MATH CONFIDENCE WORKSHOPS: A MULTIMODAL GROUP INTERVENTION STRATEGY IN MATHEMATICS ANXIETY/AVOIDANCE

BY

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by

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A person who doubts himself is like a man who would enlist in the ranks of his enemies and bear arms against himself. He makes his failure certain by himself being the first person to be convinced of it.

Alexander Dumas

So long as a subject seems dull, you can be sure that you are approaching it from the wrong angle.

W. W. Sawyer

People are anxious because they accepted an ideology that we must reject; that if we haven't learned something so far it is probably because we can't.

Sheila Tobias

I hope that any reader who has unhappy memories of past attempts at learning mathematics will be willing to accept, as a working hypothesis, that the causes were other than his own lack of intelligence.

Richard R. Skemp

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By

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Math anxiety has been shown to be a widespread phenomenon which seriously interferes with learning and severely limits academic and career choices. This study investigated the efficacy of a multimodal group intervention strategy which was planned to address math anxiety as a complex, multidimensional construct of interacting components. The design included strategies to effect cognitive and behavioral change as well as to reduce the emotional aspects of anxiety.

Six seven-week Math Confidence Groups (N = 50) were conducted. The experimental design was a repeated-measures paradigm involving pre- and posttreatment assessment on self-report Mathematics Attitudes Scales and Anxiety Inventories. All six groups showed statistically significant posttest improvement on the Confidence in Learning

Mathematics Scale, the Worry Component of the Test Anxiety Scale, and on their self-perception of mathematics ability. Five groups showed significant improvement on the Math Anxiety Scale, active enjoyment of mathematics, Test Anxiety, and Emotionality Component of Test Anxiety.

An analysis of variance by sex, group and time found males with significantly less math anxiety, greater confidence and more positive perceptions of teachers' attitudes toward them as learners of mathematics. Treatment males were significantly higher on the Usefulness Scale than treatment females at posttest. No other significant male-female differences were found. Control subjects at posttest were found to be significantly different from treatment subjects on all scales. At posttest no significant differences were found between treatment and control subjects on any of the designated scales.

The follow-up study which had an 84 percent return rate, found that positive improvement was long-lasting in such areas as math performance, ability to learn and use mathematics, and in other behavioral dimensions, as well as in the reduction of math anxiety and test anxiety. There was also felt to be a greater-than-average extent to which performance in other courses and everyday life had been improved. Perhaps more importantly, there appeared to be a long-lasting positive self-concept change in their perception of themselves as learners of mathematics. These results should be generalizable to a wide range of college students with GPAs over 2.00.

CHAPTER ONE
INTRODUCTION

Mathematics has become increasingly important in almost every aspect of our burgeoning technological society. Expertise in mathematics, statistics, computer science, and other mathematically related fields is today an essential part not only of the space industry and the natural sciences, but also the social sciences, business administration, education, the humanities, and everyday life. Fields that were relatively free of mathematics ten years ago now require skills in computers and systems analysis (Tobias & Knight, 1978). Experts predict that in the next twenty years as many as 75 percent of the work force will need computer skills (Turkington, 1982). Mathematical literacy is presently required for understanding computer printouts, cost-benefit analyses, energy problems, inflation, unemployment, the arms race, operating a business, reading the Wall Street Journal, making investment decisions, comparison shopping at the supermarket, and paying income taxes.

In 1267 English scientist Roger Bacon wrote, "Mathematics is the gate and key of the sciences." In 1972 University of California sociologist Lucy Sells in her much cited study (1973), called mathematics a "critical filter" not only for the sciences but for the majority of educational,

vocational, and professional goals. In addition, her study illustrated the extent to which women are disproportionately affected by a lack of mathematical skills. Sells surveyed the freshman class at Berkeley and found that while 57 percent of the entering male students had four or more years of high school mathematics, only 8 percent of the females had a similar background. As a result of their inadequate mathematics preparation or "math avoidance," 92 percent of the women and 43 percent of the men were ineligible for the calculus sequence and consequently for three-quarters of the available college majors.

As demands for high level mathematical backgrounds increase, it would seem that more and more students would be getting better and better prepared. The evidence, unfortunately, does not indicate this to be the case. According to Florida's Governor Graham (Cunningham, 1981) high school students in the United States are being so poorly trained in mathematics and the sciences that the country faces a "national crisis" that some day may threaten the very security of the American government. The demands of Florida's new technology industries for highly trained, skilled engineers, technicians, and machinists are not being met. Graham believes that the main reason for the math-science crisis is the extreme shortage of qualified high school mathematics, calculus, chemistry, and physics teachers. Even worse, less than half of Florida's 67 school districts have teachers who are capable of teaching calculus.

Nationwide the picture is equally bleak. Cordes (1982) presents the following statistics. In the 1981-82 school year 50 percent of the U.S. high school math and science teachers lacked proper training and taught with emergency certificates. Math scores on the Scholastic Aptitude Tests (SAT) since 1962, and three national assessments of science achievement since 1969, reveal a steady decline. Elementary students spend an average of one hour on science and less than four hours on arithmetic out of the twenty-five instructional hours in a school week. The much-heralded 1982 increase in average SAT scores which broke the 19-year decline proved to be a miniscule one-point rise in mathematics. The increase, furthermore, was due to better performance by blacks and other minorities ("Blacks Do Better," 1982). White scores remained unchanged.

The chairman of the National Science Board, Dr. Lewis M. Branscomb, told the Senate Labor and Human Resources Committee ("Panel Told High School Math Lacking," 1982) that only one-third of the nation's students take mathematics beyond the tenth grade, only 6 percent take four years of math, and one-third of the high schools do not even offer sufficient math courses to qualify graduates to enter engineering college. Shortages of mathematics teachers at the secondary level are reported by over 90 percent of the states, and approximately one-third of this country's science classes are being taught by teachers who were not college science majors. Math and science requirements are also low. Less

than 50 percent of our public high schools require more than one year of math and science for graduation (Keisling, 1982). Today's students are not being equipped for the computerized, technologically demanding society which awaits them. John Ernest (1978), mathematics professor and author of the Ford Foundation Study provocatively titled "Mathematics and Sex," summed up the situation by stating that "large numbers of students are graduating from high school as mathematical illiterates" (p. 62).

While students in the United States appear to be falling behind in mathematics and science achievement, students in Japan, on the other hand, consistently receive some of the top scores in international studies of both mathematics and science (Comber & Keevers, 1973; Glaser, 1976). One cross-national study (Stigler, Lee, Lucker, & Stevenson, 1982) found children from Japan and Taiwan consistently performing at a higher level than their American counterparts as early as the first and fifth grades. The result of the superior Japanese mathematical education is that more than half their leadership in the private and public sectors have had a science or engineering education (Tobias, 1981). The majority of the elected officials in the United States, in marked contrast, make, support, and carry out our national policy with a relatively inadequate education in mathematics and science.

All high school students in Japan, the Soviet Union, and Germany take four years of mathematics. According to a

recent National Science Foundation study (Haines, 1982), countries such as West Germany and Japan have a total work force which, because of increased educational standards, has at all levels a relatively high degree of skills in math and science. The consequences have been a very rapid expansion of technical industries which have not only matched but surpassed our technology in some areas such as in computer science.

Educators, scientists, the federal government, and other policy makers are becoming increasingly alarmed by the decline in both the quality and quantity of math and science skills in the United States and the simultaneous advances in such skills in Japan, West Germany, Russia, and other countries. Many in the scientific community believe the crisis may pose "as serious a threat to the country's economic and military preeminence as did the Soviet's launching of Sputnik 25 years ago" (Cordes, 1982, p. 3).

It appears that there is agreement on the following conclusions: There is a growing national problem of diminishing math and science skills. Japan, Russia, and Germany are surpassing this country in math and science education. In time, if not corrected, this difference could make an impact on our industrial productivity, perhaps even in our national defense. Such a deficit of math and science skills will certainly affect the quality of preparation given to the nation's young people for living in a highly technological world.

Agreement is lacking, however, as to the causes, the solutions, or even who should provide the leadership in solving this complex problem. Funding poses an even larger obstacle. The National Science Board, which sets policy for the National Science Foundation, has named a commission to diagnose and prescribe a cure for the growing national math and science illiteracy (Cordes, 1982). There have been only two other such special panels in the history of the board. In order to upgrade math, science, and technology in the schools, the Reagan Administration is considering the formation of a "Cabinet-level task force on the educational skills needed for national economic growth and national security purposes" (Cordes, 1982, p. 3). Administration officials have been careful, however, to suggest that the federal government should not be expected to supply the funding, enforce mandatory national policies or be the ultimate solution to this problem. Nor is it realistic to expect business interests to be of any significant aid.

As the controversy continues at the national level, other work is being done and other measures being taken nationwide to give insights into the causes for the problem and suggestions for change. The math-science crisis is extremely complex. Assessments must be made and solutions proposed at several levels.

Possible Causes for the Mathematics and Science Crisis

One explanation for American children's comparatively inferior mathematics performance may be that they receive considerably less instruction in mathematics (Stigler et al., 1982). In Taiwan and Japan children are in school for five and one-half days each week, attend school for more weeks of the year, and spend a larger percentage of the time in school studying mathematics, 23-25 percent in Japan as opposed to 14-17 percent in the United States.

In addition to fewer numbers of hours taught, of importance also is the quality of those hours, how mathematics is taught, and with what enthusiasm and expertise. Research has shown that a negative attitude towards mathematics can be the result of a negative experience with just one teacher (Ernest, 1976; Poffenberger & Norton, 1956; Sells, 1973). Many teachers, unfortunately, have been shown to have negative attitudes toward mathematics (Aiken 1970; Ernest, 1976). Gray (1977) suggested that education majors, especially in elementary education, were often those "who have shut themselves off from many careers by their attitude toward mathematics, the very attitude that should not be passed on to their students (female or male)" (p. 375). These findings are particularly distressing in view of the conclusions by Banks (1964) and Aiken (1970) that of all the factors affecting student attitudes toward

mathematics, teacher attitudes were "by far the most significant contributing factor" (Banks, p. 17).

Posamentier and Stepelman's (1982) study of the increasing shortage of qualified mathematics teachers makes the future look even more somber. They found that lucrative fields such as computer programming were now attracting the talented college students who formerly might have considered teaching mathematics. The expanding career choices of women, the declining attraction of teaching as a profession, and private industry's increased competition appear to be the major causes for the impending crisis in mathematics education (Paul, 1981).

Mathematician Peter Hilton (1980) suggested that the principal causes of math incompetence and math avoidance were "bad teaching, bad texts, and bad educational instruments" (p. 176). Others (Gough, 1954; Sawyer, 1943; Skemp, 1971) agreed that a fear of mathematics can be an understandable result of bad teaching, poorly written textbooks, mistaken beliefs and expectations, and a lack of understanding of the learning process.

Some mistaken beliefs are that mathematics and science are elitist subjects understood by people, usually men, who have a rare gift and who may be odd or different from other people. A mystique then forms around math and science courses. They are too difficult for most people to understand. Their perceived usefulness is low. A "minimalcy mentality" (Sells, 1978b) arises. Just take the required courses

and try to get by with memorizing. Humanities and the sciences become artificially split into two distinct groups. In The Two Cultures and the Scientific Revolution C. P. Snow (1959) analyzed the lack of communication between the two camps. Their physical and administrative separation on college campuses widen the gap further, and stereotyping "mathematical/scientific minds" suggests that mathematical and scientific reasoning are somehow separate and inborn reasoning powers of the mind. According to physics professor J. V. Mallow (1981), author of Science Anxiety: Fear of Science and How to Overcome It, this scientific elitism has grown up only in the last 40 years.

Astronomer Carl Sagan, director of the Laboratory for Planetary Studies at Cornell University, believes science should once again be readily accessible to the public. Children are natural scientists, he said, but are stifled by parents and bored and misled in school until they believe that they are too dumb to understand science. He saw a danger in the growing split between a small scientific elite and the scientific illiterate majority. Sagan considered it "more than a crisis. It is a scandal. It is suicide" (Cordes, 1982, p. 16).

Suggestions for Change

In the relatively few years since Sells' 1973 "critical filter" research, the study of women and mathematics has gained national attention. Sheila Tobias' popularization

of the term "math anxiety" (1976, 1978) together with the writings of other respected educators and researchers (Casserly, 1980; Ernest, 1976; Fennema, 1977; Fox, 1977; Helson, 1980; Sherman, 1977) have contributed to this prominence.

Although there are risks involved with the use of the term "math anxiety" (Blum, 1978, Ernest, 1976; Luchins, 1979), several important efforts have developed concurrently with the popularization of the term. Research attention has been focused on the causes and consequences of sex differences in mathematics achievement and on the societal, educational, and career barriers experienced by women. Attempts have been made to educate young women, their parents, teachers, and counselors regarding the vital importance of mathematics and the limitations imposed by math illiteracy. The Mathematical Association of America funded two groups, Blacks and Mathematics and Women and Mathematics, to provide speakers and role models for high school girls. Lenore Blum's Math/Science Network at Mills College actively encourages young women to pursue careers in math and science. At the post secondary level, intervention programs across the country are demonstrating that math deficient but otherwise academically competent adults can learn mathematics (Tobias & Weissbrod, 1980).

On another front, psychologists are collaborating with mathematicians and physicists to gain understanding of the processes involved in learning math and science. Cognitive

research findings are helping teachers to identify and remedy problem areas, such as students' difficulties in replacing their former naive theories with what they learn in math and science classes and applying these new principles to real-life problems (Resnick, Note 1).

Educators are also revising mathematics standards in the schools. Minimal competencies of college students have been examined, and additional testing is now being required. In the state of Florida, for example, the legislature recently mandated special competency tests for prospective teachers as well as increased the level of math and English courses required of lower division college students. Students will be required to take college-level academic skills tests before they can advance to junior status. Basic-skills testing programs have been instituted at all levels of education in an effort to overcome what Florida education commissioner Ralph Turlington described as a "laxness" in setting standards for schools (Haines, 1982).

The Florida college sophomore basic-skills testing will further reveal the already existing problem of math illiteracy. As noted earlier, there are far too many students, who, because of poor counseling and a myriad of interrelated factors, discover too late that they should have learned more math in high school. Many students, for example, try to learn material for the first time in a fast-paced math review course of several hundred students. Others believe that they are in math "flunk-out" courses and that everyone

else understands what to do. They may also believe that they lack a "mathematical mind," that there is a ceiling on ability and they have reached their ceiling. This can happen anywhere from fractions all the way up to Calculus III. And it can, and often does, happen to "A" students. Otherwise academically competent students can feel helpless, unable to use their normal coping behaviors. As their anxieties rise, their confidence falls. Comprehension, memory, attention, and concentration all decline.

Often, but not always, the anxiety leads to the most common and simplest means of relief--avoidance behaviors. The students, consequently, may appear dumb, lazy, and self-defeating even to themselves. Many of these students believe that they are beyond help, so firmly are they convinced that the problem is their own lack of mathematical intelligence. And many professors, baffled by the students' difficulties and not understanding the psychological blocks they are experiencing, are also unable to help them. Some students become angry and resentful of the large classes and the math requirements when they "aren't ever going to use math anyway." Some students, frustrated and bored by years of rote-learning without understanding believe that math and mathematicians must be dull and noncreative. These students begin class with a strong, long established aversion both to the subject and to the professor. This attitude baffles the professors even further. Other students, determined to avoid math at all costs, proceed to plan their

entire academic and professional careers with that goal in mind even if the costs include giving up their first, second, and third career choices.

What then are the implications? Too many students, especially women and minorities, are not fluent in a key language, mathematics, which opens up academic and vocational opportunities. It is this lack of fluency which undermines feelings of competency. "Math illiteracy" keeps people from being able to understand discussions in all fields which rest on mathematical metaphors. Being able to do math and science is to have power, to have a sense that you have the tools needed to speak the language of technical arguments and to make intelligent decisions on political or financial issues which have a mathematical or scientific base. Lacking mathematical competence is to be cut off from full participation in our increasingly technological society.

Purpose of the Study

One component, therefore, of solving the math-science crisis is to help these math deficient but otherwise academically competent students to "learn how to learn" mathematics in what can be called Math Confidence Workshops. The purpose of this study was to establish such a program. The goals were to help the students 1) replace their self-defeating attitudes, beliefs, and behaviors with more beneficial ones, 2) manage their anxiety more effectively, 3) gain confidence in their mathematical intuition,

reasoning powers, and overall ability to learn mathematics, and 4) gain control, to stop feeling helpless, and to use already established academic coping behaviors.

The problems involved included 1) educating students, counselors, and faculty that such an intervention was available and possible; 2) getting students to come for help (Tobias (1978) suggested that it can take as long as three years of "patient development" before even learning the number of potential users); 3) assessing which students would benefit from such a program and screening out and/or providing alternative interventions for other students; 4) designing a multifaceted intervention which would meet the needs of students at varying levels of avoidance behavior, anxiety, and mathematical and academic expertise; 5) accomplishing Numbers 1-4 as a part of a low-cost intervention at a University Counseling Center with the endorsement of the Department of Mathematics (although without their financial or professional contribution to the program development).

There are a wide variety of math anxiety reduction programs at colleges and universities across the country. Tobias and Weissbrod in the Harvard Educational Review (1980) see the development of effective, controlled, intervention techniques as essential in reversing mathematics underachievement at the postsecondary level. There have been, however, only a "handful" of controlled investigations of these treatments (Richardson & Woolfolk, 1980) and

"systematic evaluation of programs to remediate math anxiety, both counseling and educational programs, are sorely needed" (p. 285).

In summary, it has been established that mathematics has become increasingly important in our society, that the lack of mathematical competence among students and the public at large has reached crisis proportions, and that there is a need for nationwide interventions at multiple levels to meet this crisis. For many students psychological interventions are needed to address the math anxiety which they are experiencing. The theoretical basis for understanding the concept of math anxiety is poorly defined (Anton & Klisch, in press). Empirical research is limited on the nature of math anxiety, its effects, prevalence, and strategies for treatment. Interventions have leaned heavily on test anxiety research which, after a history of unidimensional approaches, has currently suggested a complex conceptual model of test anxiety (Meichenbaum & Butler, 1980) and multidimensional treatments which address this complexity. It was the purpose of this study to determine the efficacy of a multidimensional group intervention approach in the treatment of math anxiety as reported by college students.

Specific Objectives

The specific objectives of this research were to investigate

1. the pre- to posttreatment change on the following scales:

   a. Math Anxiety
   b. Confidence in Learning Mathematics
   c. Math as a Male Domain
   d. Usefulness of Mathematics
   e. Effectance Motivation in Mathematics
   f. Test Anxiety
   g. Worry component of test anxiety
   h. Emotionality component of test anxiety

2. treatment subjects' perception of their ability in mathematics

3. maintenance effects of anticipated treatment improvement.

It was anticipated that

1. there would be significant pre- to posttreatment improvement on all scales or, in cases of nonsignificant posttest improvement, that the posttreatment scores would be comparable to those of the nonanxious comparison group, the Psychology I control group, or the math classes control group.

2. there would be a significant improvement in subjects' self-reported math ability ratings.

3. subjects would report continued improvement in treatment areas including ability to learn and use mathematics, performance in mathematics courses, decrease in math and test anxiety, and in other specific behavioral dimensions addressed in the math groups up to 1 1/2 years after the intervention program.

Having set forth the purpose, specific objectives, and need for the present study, the next chapter will review

the literature, and Chapter Three will describe how the study was conducted. Chapters Four and Five will describe the results and discuss their implications.

CHAPTER TWO
REVIEW OF THE LITERATURE

In this section the relevant literature has been divided into several main categories: background information and possible causes of negative attitudes toward mathematics from the perspective of mathematics educators, women and mathematics, the relationship of math anxiety to test anxiety, and empirical studies of the treatment of math anxiety.

The concept of math anxiety is not a new one. As early as 1954 Gough wrote on "mathemaphobia"; in 1957 Dreger and Aiken identified "number anxiety" in a college population; in 1966 Natkin devised a simple paired-word association treatment of "mathematical anxiety"; and in 1972 Richardson and Suinn developed a Mathematics Anxiety Rating Scale (MARS).

Although systematically collected information on the prevalence of math anxiety is somewhat limited, math anxiety has been found to be a frequent problem of college students (Betz, 1978; Probert, Note 2; Richardson, Note 3). Richardson surveyed 400 undergraduate students and found that approximately one-third experienced extreme levels of anxiety associated with number manipulations or situations involving mathematics. In Betz's study from one-fourth to

one-half of 652 undergraduate subjects reported that math made them feel "uncomfortable and nervous" and "uneasy and confused" (p. 443). Approximately half of the 80 students in mathematics classes for elementary school teachers surveyed by Probert reported some extent of anxiety when faced with various situations involving mathematics. Only one-fourth of the students indicated that they were not "uptight" or "ill at ease" during math tests (p. 56).

Controlled research on the nature of math anxiety is even more limited than on its prevalence. Anton and Klisch (in press) have noted that as a result of the poorly defined theoretical basis underlying the concept of math anxiety there is a "virtual absence" of controlled research on the variables which lead to negative cognitive and emotional responses to mathematics. Lacking these data, it is necessary to look elsewhere for the needed background information on the complex nature of math anxiety, its multiple causes, origins, and perpetuators.

The Nature of Math Anxiety from the Mathematics Educator's Perspective

From as early as 1943, educators in mathematics have identified fear of mathematics, mathemaphobia or mathophobia as a widespread phenomenon, speculated as to its causation and cure, written books and articles on the subject, and helped students overcome it in their classrooms. These

teachers did not hesitate to identify members of their own profession as major contributors to the problem. The condemnation of rote-learning appeared as a recurring theme. Reviewing the writing of a number of these math educators provided insights pertinent to math anxiety intervention strategies.

An English mathematician and educator, W. W. Sawyer, wrote Mathematician's Delight (1943) primarily to "dispel the fear of mathematics" (p. 7). Sawyer identified bad teaching as the cause for the dislike or dread of mathematics. Bad teaching, according to Sawyer, stresses parrot-learning instead of understanding, does not encourage mathematical reasoning, intuition or imagination, and encourages the belief that mathematicians are a race apart with almost supernatural powers. Mathematics has been presented too often as "imitation mathematics," as dull drudgery, something far removed from everyday life. Sawyer believed that the first step toward overcoming the problem was to get rid of the fear, to go back to the earliest stage where confidence was lost. He envisioned mathematical reasoning and imagination developing gradually through direct experience with real objects. Mathematical reasoning is not separate from other reasoning powers of the mind. The same methods of reasoning are used by people in their everyday lives, but they are not aware of it. "The important thing is to learn how to strike out for yourself. Any mistakes you make can be corrected later. If you start by trying to be

perfect, you will get nowhere. The road to perfection is by way of making mistakes" (p. 24).

In Vision in Elementary Mathematics (1964) Sawyer re-emphasized the problems arising from the too frequent expectation of failure generated by the loss of confidence which bad teaching causes and by the common belief that only geniuses can learn mathematics. He additionally pointed out the widespread incorrect assumption that memorizing is easy and understanding is difficult. Teachers, unfortunately, as well as students often believe that only the truly gifted can understand what mathematics really means. The others will just have to get by with rote-learning. The truth is exactly the opposite; memorizing what is not understood is extremely difficult.

In 1954 Sister Mary Fides Gough, a teacher of mathematics for more than twenty-five years, suggested that "mathemaphobia" was a major cause of the many failures she saw in mathematics classes. This disease, she said, needed no defining, was "almost as common as the common cold" (p. 290), and could undermine self-confidence years before being detected. Early embarrassment by a teacher, missed concepts such as fractions because of absences from school, fear of failure, teachers who require memorizing instead of understanding or who suggest that mathematicians are born with a magic gift, and "hereditary mathemaphobia" ("My father never could learn mathematics and I can't learn it either")--all contribute to the development of the phobia.

Gough suggested that students' failure to master mathematical reasoning comes from their fears and from their belief that such ability is beyond them.

Another mathematician, Richard Skemp, became so concerned with the problem of intelligent and hard-working students who "couldn't do mathematics" that he returned to college for a degree in psychology in order to help them. Skemp wrote in The Psychology of Learning Mathematics (1971) that many people acquire a "lifelong dislike, even fear, of mathematics" because of a lack of good teaching especially in the early stages. He stated that the first two principles of the teaching of mathematics were

> 1) Concepts of a higher order than those which a person already has cannot be communicated to him by a definition, but only by arranging for him to encounter a suitable collection of examples.
>
> 2) Since in mathematics these examples are almost invariably other concepts, it must first be ensured that these are already formed in the mind of the learner. (p. 32)

According to Skemp the vast majority of textbooks violate the first of these principles. Regarding the second principle, if a particular level of mathematics was not understood perfectly, almost all remaining levels suffered. Because many students learn to do manipulations by rote-learning with a most inadequate understanding of the underlying principles, it was no wonder that mathematics became a mystery to them. "For those with feelings of dislike,

bafflement, or despair toward mathematics," Skemp suggested "the fault was not theirs--indeed, . . . these responses may well have been the appropriate ones to the non-mathematics which they encountered" (p. 114).

Skemp stated further that bad teaching in the form of a series of meaningless rules can be described as a series of "insults to the intelligence." And it is probably the more intelligent students who are the most upset by these rules without reasons but who do not realize that the fault is not theirs. Teachers, perhaps meaning well but acting in ignorance, either present definitions or rules which are not meaningful or else do not give the preliminary ideas basic to the understanding of the new ones. The students, without the schemas or concepts necessary for comprehension readily available in their minds, only accept the teacher's authority if any learning is to take place at all. Such learning is not schematic-learning; it is rote-learning.

Sooner or later, however, the entire defective system breaks down. As mathematics becomes more advanced, the increasing amount of information to be memorized poses an impossible task for any learner. Rote-learning cannot be adapted to seemingly different problems which are based on the same mathematical principles. Schematic learning is more adaptable and does not impose such impossible burdens on the memory.

The students, not knowing what the problem is or perhaps thinking themselves incapable of real understanding,

find themselves in an anxiety-provoking situation. Trying to memorize more and more rules and methods without understanding provides no basis for long-term retention. Progress is impeded, self-esteem sags, and anxiety mounts. As the anxiety mounts, a vicious circle is established. Anxiety makes it even more difficult for students to learn. So the harder they try, the less able they are to understand, and the more anxious they become. According to the Yerkes-Dodson Law, with increases in arousal or anxiety, task performance increases up to a certain point, beyond which additional anxiety or motivation leads to a decrease in performance. The optimal level of arousal decreases with the complexity of the task. For complex tasks, such as doing algebra, the optimal level is lower than for simple tasks. When even a mathematics book or a calculus class has become a conditioned stimulus for anxiety, the problem is exacerbated.

In Skemp's statistics class for psychology majors, he found that his first task was to convince many students that they were capable of comprehending mathematics. Skemp pointed out that good teachers can reduce anxiety, build up confidence, and improve performance by starting with questions which they know students can answer. Other teachers can reduce a pupil of average intelligence to "tongue-tied incompetence" (p. 128). It was Skemp's hope that all those who have had unsuccessful attempts at learning mathematics would "be willing to accept, as a working hypothesis, that the causes were other than (their) own lack of intelligence" (p. 129).

More recently Lazarus (1974) and Zacharias (1976) both wrote about mathophobia as a widespread phenomenon which can seriously impair performance. Lazarus defined mathophobia as "an irrational and impeditive dread of mathematics . . . (an) emotional and intellectual block making further progress in mathematics and closely related fields very difficult" (p. 16). The attitude and the anxiety make learning difficult, pessimistic predictions are justified, frustration feeds the anxiety, and the attitude worsens further. Lazarus gave credit to Zacharias for coining the term "mathophobia" and speculated that mathophobes constitute a clear majority of people in this country. A complex interaction of factors seems to be responsible. The educational system was cited as promoting mathophobia by not providing early diagnoses of the problem or even by teaching the memorize-what-to-do approach rather than a real understanding of the material. Parents were cited for transmitting negative attitudes or adopting pessimistic expectations. The nature of mathematics and the mathematics curriculum were also cited. The sequence in which mathematical topics are presented to students tends to be historical or based on the perspective of adult logic rather than on studies of children's developing capabilities. Mathematics, in contrast with almost all other subjects, tends to build on itself cumulatively. Missing a concept, for whatever cause, can have lasting and cumulative results.

Perhaps the most serious problem of all, according to Lazarus, is the probability that a significant proportion of mathematics teachers may themselves be suffering from mathophobia. As to why people who dislike mathematics would put themselves in the position of teaching it, Lazarus suggested that a partial answer lies in the incorrect belief in the "mathematical ceiling"--the level at which people first experience difficulty in learning mathematics. Some teachers, believing that they have reached their "ceiling," have lost all pleasure and fascination in the subject, never want to learn anything more about mathematics, and discourage probing questions and exploration of new techniques. They still may feel capable of teaching any level of mathematics as long as it is below their individual "mathematical ceilings." Lazarus felt strongly that an "indiscriminate (though not uncritical) love of the subject" (p. 22) was an essential element to excellent teaching. Indifference and negative attitudes will be passed on to students. Mathematics may then become dull, pointless drudgery.

Women and Mathematics

Sawyer (1943, 1964), Gough (1954), Skemp (1971), Lazarus (1974), and Zacharias (1976) all wrote of the difficulties in learning mathematics encountered by a large proportion of students, both male and female. Recent research has illustrated that many females in our culture

experience pressures and negative messages which may additionally affect their learning of mathematics and/or their decisions whether to enroll in or to avoid higher level mathematics.

The study of women and mathematics is a relatively recent phenomenon prompted by the increasing realization that women with apparently equal aptitudes are disproportionately represented in the sciences and other fields requiring mathematical competence. In response to Lucy Sells' (1973) study on "math avoidance" at the University of California, Sheila Tobias (1976, 1978) and others popularized the term "math anxiety" and suggested that sex-role socialization and other societal influences were responsible for the sex differences at the higher levels of math and science.

Mathematics has been defined in our culture as masculine (Fox, 1977). Textbooks, tests, literature, television programs, and the media all contribute to this stereotype. Role models are lacking for females in mathematics and science. Parents, counselors, teachers, and peers are likely to perpetuate sex-role stereotypes by believing and reinforcing sex differential expectancies for math achievement (Probert, Note 2). And women themselves are more apt to underestimate their ability to solve mathematical problems and to perceive themselves as mathematically incompetent (Fox, 1977).

Bem and Bem (1970) speak of a "nonconscious ideology" which they define as those implicitly accepted beliefs and attitudes of which one is unaware because the same message is disseminated by all reference groups and alternative conceptions of the world are not even examined. They suggest that an American woman is trained to "know her place" because of the pervasive sex-role ideology which results in differential expectations and socialization practices. One such commonly accepted belief is that mathematics is a male domain.

John Ernest's (1976) study, "Mathematics and Sex," concluded that mathematics is a sexist discipline, that the immorality of the sex differences in mathematics performance is that they are caused by stereotypes, attitudes, restrictions, and constraints. Elizabeth Fennema (1974) agreed with Ernest that these sex differences are "a major failure of our pedagogical system" (p. 609).

It was not until 1974 that there began to be serious questioning (Fennema, 1974, 1977) of the common assumption that, at least as early as adolescence, males were innately superior in mathematical achievement and that this superiority increased with age and with the difficulty of the material. This belief in male superiority was reflected in Maccoby and Jacklin's (1974) highly quoted review of the literature on psychological gender differences which concluded that boys' greater visual-spatial and mathematical abilities were "well-established" differences. Less well

known was the fact that these differences although well established were literally very small (Hyde, 1981; Sherman, 1977, 1979). Tobias (1982) argued further that "until and unless girls can experience the world as boys do, we cannot assume that sex differences in math are genetic" (p. 14).

While the question of sex-related differences in mathematical aptitude is still being researched and debated (Benbow & Stanley, 1980; Schafer & Gray, 1981; Tobias, 1982), it is now widely accepted that there are no sex-related differences in elementary school children's mathematical learning (Fennema, 1977) and few sex-related differences before high school (Aiken, 1976; Fennema, 1974, 1977; Maccoby & Jacklin, 1974). In addition, when Fennema and Sherman (1977) controlled for mathematics background and general ability, few differences in achievement were found during high school, and score distributions overlapped considerably.

There are, however, large sex-related differences in students electing to study mathematics at the upper levels of high school and in college (Ernest, 1976; Fennema & Sherman, 1977; Sells, 1978a). Although Ernest (1976) found no statistically significant sex differences in the grades achieved in university level mathematics courses, the female dropout rate in many math classes was almost double that of males, and attrition rates were higher for women than for men among mathematics majors. These differences in course selection and dropout rates contribute to large sex-related differences in academic and career opportunities.

Math Anxiety and Test Anxiety

Math anxiety and test anxiety appear to have many common features, and researchers (Hendel & Davis, 1978) have suggested that the two concepts may be functionally similar. It appears, however, that not all people who have high scores on math anxiety scales also have high ratings on test anxiety scales. The issue is complicated by an overlap in item content inasmuch as math anxiety scales have items relating to mathematics tests.

Suinn (1970) reported that of the students requesting treatment in a behavior therapy test anxiety program, over one-third had problems centering around mathematics anxiety. Suinn and Richardson (1971) found that students in a mathematics anxiety treatment group had significantly higher scores on the Suinn Test Anxiety Behavior Scale (STABS) than did the controls. More recently other researchers (Betz, 1978; Probert, Note 2) have reported on the relationship between math anxiety and trait and test anxiety. Higher levels of math anxiety, as measured by a modified version of the Fennema-Sherman Mathematics Anxiety Scale, were found to be significantly but moderately correlated with higher levels of trait anxiety, overall test anxiety, and emotionality and worry components of test anxiety.

In their review of the literature Richardson and Woolfolk (1980) conclude that "clearly, math anxiety is related to test anxiety, but the two are by no means equivalent phenomena" (p. 278).

Anton and Klisch (in press) observed many parallels between math anxiety and test anxiety and suggested that examination of the test anxiety literature would be helpful for understanding math anxiety. Although the literature on test anxiety dates back over 40 years (Spielberger, Gonzalez, Taylor, Algaze, & Anton, 1978), George Mandler and Seymour B. Sarason (1952) are generally credited with the first important theorizing in the area. Mandler and Sarason, influenced by Hullian drive theory, attributed the relatively poorer performance of high test-anxious students in evaluative situations to the detrimental effects of learned, task-irrelevant anxiety drives. Learned task drives and task-relevant anxiety drives, they theorized, facilitated test performance. Alpert and Haber (1960) contributed the constructs of facilitating and debilitating anxiety. Much of the early research focused upon the debilitating effects of test anxiety on cognitive task performance.

Wine's (1971) direction of attention interpretation suggested that test-anxious students divided their attention between "self-relevant" and "task-relevant" responses in contrast to low test-anxious students who focused their attention completely on the task. Woolfolk and Richardson (1978) summarized four dimensions of anxious functioning found in test-taking situations as follows: 1) Negative self-talk which may include self-escalating, self-perpetuating worry, self-criticism, self-condemnation, and

preoccupation with bodily reactions, 2) Self-evaluative, self-oriented thinking instead of task-oriented thinking, 3) Ineffective response to bodily signs of tension, and 4) Irrational, maladaptive beliefs about self and the world.

There is now general acceptance of Liebert and Morris's (1967) suggestion that test anxiety consisted of two major components, worry and emotionality. The worry component was described as "primarily cognitive concern about the consquences of failure" (p. 975). Emotionality was seen as the affective-physiological reactions which were evoked by increased autonomic arousal. Particularly pertinent to those interested in treatment interventions has been the consistent reporting (Deffenbacher, 1980; Tryon, 1980) that the worry component has been significantly negatively related to intellectual and cognitive performance; emotionality, on the other hand, appears to be unrelated to performance measures.

Deffenbacher (1980) after reviewing the literature on worry and emotionality components made the following suggestions for anxiety-reduction treatment programs: 1) Cognitive restructuring of worry combined with training in task-oriented self-instruction should have promising results. 2) Cognitive restructuring, by providing coping skills for the preexamination period as well as for the actual test-taking time, could reduce avoidance behaviors and improve the quality of preexamination learning. 3) Self-managed

relaxation for the reduction of emotionality could be added to cognitive restructuring coping skills inasmuch as some studies show an interaction between emotionality with worry levels. 4) Because emotionality is highest at the beginning of an examination and decreases during the course of the test, relaxation training might most opportunely be cued to the period just prior to the examination (Deffenbacher, 1977).

There are well over 50 controlled outcome studies of test anxiety appearing in the literature (Denney, 1980). Systematic desensitization, growing out of Wolpe's (1958) seminal work based on counter conditioning and extinction, is still the most common treatment intervention. Since Wolpe's original formulation, however, there has been a questioning of his mechanistic interpretation of change. As an alternate hypothesis, it has been suggested that the principal mechanism for anxiety reduction in systematic desensitization involves changing subjects' beliefs in their ability to cope with certain situations (Murray & Jacobson, 1978) and/or their sense of efficacy or mastery (Bandura, 1977). Cautela (1969) and Goldfried (1971) made important contributions toward reconceptualizing systematic desensitization as a "procedure for developing self-control instead of a passive desensitization" (Murray & Jacobson, 1978, p. 677).

A recent review of 49 test anxiety outcome studies (Allen, Elias, & Zlotlow, 1980) reported the following:

there were differences on performance measures of test anxiety between treated and untreated groups for just 50 percent of all behavior therapy studies since 1970 and for only 33 percent of those which involved systematic desensitization. Denney (1980) reviewed 18 studies using self-control procedures and found the following rates of improvement on performance measures: 33 percent (1 of 3) of applied relaxation techniques, 50 percent (4 of 8) of self-control training techniques, and 71 percent (5 of 7) of cognitive coping techniques. It can be noted that when cognitive restructuring was incorporated (i.e., cognitive coping techniques), the rate of success was markedly higher.

Component analytic studies have looked at the efficacy of cognitive restructuring and relaxation which are both used in cognitive modification (Meichenbaum, 1972). Two such studies (Wine, 1971; Holroyd, 1976) found that the effective coping strategy involved was cognitive restructuring while a third study (Hahnloser, 1974) found that both components had to be incorporated in order for cognitive modification to be effective.

Tryon (1980) reported four procedures which were found to change students' grades: cognitive counseling (Holroyd, 1976), study counseling (Allen, 1973), study counseling with systematic desensitization (Allen, 1971), study counseling with relaxation (Allen, 1973). All four included cognitive interventions which helped subjects replace negative self-reference thoughts with task-oriented thinking. In general,

Tryon concluded that study skills alone were found to be less effective than study skills in conjunction with another treatment procedure.

Allen (1972) was the first reviewer to point out that the various behavior therapy treatment approaches, systematic desensitization, anxiety management, implosion, cue-controlled relaxation, autogenic training, active coping relaxation, and biofeedback, all focus on emotionality reduction. Allen found that in order to obtain reliable cognitive performance improvement, it was necessary to combine such approaches with some form of cognitive treatment approach. Wine (1980) was emphatic in her criticism of test anxiety treatment approaches which evolved out of other anxiety treatment techniques rather than from the research findings on the nature and effects of test anxiety. Wine (1971) wrote that ". . . by training test anxious subjects to relax in the presence of progressively more stressful stimuli, a systematic desensitization treatment approach assumes that the emotional arousal component of test anxiety is its defining characteristic" (p. 101).

Wine stated there was mounting evidence to show that it was the cognitive worry component (i.e., negative self-preoccupation and attention to evaluative cues rather than to task cues) which was shown to be the most important characteristic of test anxiety.

Wine (1980) summarized her review by stating that the test anxiety treatment literature "reveals that researchers

in this area, by and large, continue to adhere to an emotional reactivity interpretation of test anxiety. The evidence points to the inescapable conclusion, however, that cognitively based treatment strategies are more powerful in effecting cognitive performance change and as effective in reducing self-report test anxiety level as are emotionality-based approaches" (p. 375). Tryon (1980) in her review of the test anxiety literature concluded that "systematic desensitization and similar treatments designed to reduce the emotional aspects of test and mathematics anxiety should probably fall into disuse" (p. 366).

Meichenbaum and Butler (1980) propose a complex conceptual model of test anxiety as interacting components which result in a kind of self-perpetuating cycle.

> The individual is caught in a type of vicious cycle, a self-perpetuating trap in which the meaning system, internal dialogue, behavioral acts, and interpretation of consequences feed upon each other. In this framework, test anxiety should not merely be equated with poor study skills, or task-irrelevant internal dialogue, or irrational beliefs, or unrealistic expectations. Instead, test anxiety is a construct that summarizes this entire chain of events. (p. 204)

Consequently, complex cognitive treatment packages (Wine, 1980; Meichenbaum & Butler, 1980) may be the most effective treatments of all. Tryon (1980) suggested the efficacy of "complex, multimodal package treatments which influence the individual's meaning system, internal dialogue, behavioral acts, and interpretation of behavioral outcomes"

(p. 366). Multimodal interventions such as stress-inoculation training (Meichenbaum, 1975), anxiety management training (Richardson, 1976), and multimodal behavior therapy (A. Lazarus, 1976) are among those treatment strategies which address test anxiety as a multidimensional construct.

The Treatment of Math Anxiety

Many of the behavioral therapy treatment procedures which have been used to treat test anxiety have been applied to math anxiety. Treatment studies of math anxiety in the empirical literature date back only to 1970 when Suinn, Edie, and Spinelli treated mathematics anxiety in 13 college students by means of two short-term desensitization approaches. The marathon desensitization group (MDG) received a standard systematic desensitization procedure using the entire nine-item hierarchy in five treatment blocks massed within four consecutive hours on one evening. The accelerated massed desensitization group (AMDG) received only the highest three items of the hierarchy in two treatment blocks for two consecutive hours. The AMDG showed as much improvement in MARS scores and in mathematics performance on the Differential Aptitude Test (DAT), with a 10-minute time limit, as did the MDG. The fact that there was no control group makes improvement on both measures difficult to evaluate.

Suinn and Richardson (1971) found that Anxiety Management Training (AMT) was as effective as standard systematic desensitization in reducing math anxiety as measured by the MARS in a study of 24 college students. A significant improvement in DAT scores was achieved only by the desensitization group. The control group consisted of 119 untreated, nonmathanxious psychology students. Anxiety management training (AMT) is a nonspecific anxiety self-control program which does not use anxiety hierarchies. Subjects, instead, were instructed to generate anxiety responses and then trained to develop competing responses, such as relaxation or feelings of success.

A third study (Richardson & Suinn, 1973) compared traditional systematic desensitization, accelerated massed desensitization (AMD), and anxiety management training (AMT) in the treatment of mathematics anxiety. All three treatments were found to have significant, equivalent improvement on the math anxiety scale (MARS), but no significant differences were found on the mathematics performance measure (DAT). Two control groups were formed by selecting students with high scores on the MARS from a group participating in research to earn credit for education courses. The second group was selected for comparison on the MARS after it was discovered that the MARS scores of the first group were much higher than those of the treatment subjects. It was felt that there might be a reduction in scores due to regression toward the mean. The first group was retained for comparison

on the DAT. None of the control group subjects had expressed interest in the math anxiety reduction program.

Tryon (1980) reviewed the above three studies and suggested that "the threats to internal validity in these studies make it difficult to draw conclusions about the effectiveness of the treatment procedures" (p. 364). Tryon seemed particularly concerned about the absence of a control group in the first study and the nonequivalent control groups in the other studies.

There was also a highly selective method of obtaining subjects for treatment in the three studies. Students were eliminated not only for severe psychological disturbances but also for inadequate mathematics backgrounds, lack of ability, apathy about school, vocational or other personal difficulties, and anxiety "primarily connected with test-taking in general" (p. 213). Generalizability is in question especially because math anxiety and math avoidance often are caused by and/or result in inadequate backgrounds in mathematics (Tobias, 1978).

In regard to the performance measure, Richardson and Suinn suggested that the improvement found in DAT scores in the first two studies may have been "due, at least in part, to the practice effects involved in retesting" (1973, p. 216) on the same form. They suggested further that the use of available equivalent forms of the DAT might remedy the problem.

The problem of performance improvement appears, however, to be much more complex than changing DAT forms. Extensive test anxiety research, reviewed earlier, concluded that it was cognitively based treatments which were more effective in achieving improvement in performance and as effective in reducing emotional arousal as emotionality reduction treatments such as those used in the previous three studies. Richardson and Woolfolk commented later (1980) in their review that

> these three studies encouraged the belief that behavior therapy programs of this type have an impact on math anxiety, but they do not clearly demonstrate effectiveness in improving math performance, in maintaining this improvement, or in modifying other attitudes that may mediate participation and pleasure in mathematics-related activities. (p. 283)

Treatments involving cognitive strategies have also been applied to math anxiety. Albert Ellis's (1962) rational-emotive therapy has influenced a majority of the current cognitive restructuring approaches. Ellis pointed out that anxiety and other maladaptive emotional reactions are often the result of maladaptive, irrational thoughts, beliefs, and expectations. There is empirical support for this basic assumption that self-statements are capable of eliciting emotional responses (Goldfried, 1977), and it is this assumption that has influenced cognitive relabeling procedures used in anxiety reduction.

Typical "irrational" beliefs which have been shown to create problems for the math anxious are "other people have mathematical minds, but I don't so I can't do math"; "people are either mathematical or verbal, but not both"; "if I got the answer that fast, it must be wrong"; "only men can do 'real' math"; "mathematicians are geniuses who have never had any difficulty doing math"; "there is only one correct way to do a math problem."

Stanley Kogelman and Joseph Warren developed five-session therapy workshops described in their book, Mind Over Math (1978), in which they focus on changing attitudes and irrational beliefs in order to help people overcome their fear of mathematics. They argue that it is the emotional blocks, the intense emotional reactions to mathematics, which make teaching and learning virtually impossible. Although both Kogelman and Warren are mathematicians, their main focus is on the psychological intervention which they believe is necessary before learning math can be possible. Although no empirical research has been published, Kogelman and Warren stated that they had been able to help everyone who came to their workshops.

A multimodal, cognitive-oriented intervention strategy for reducing mathematics anxiety was reported by Hendel and Davis (1978). They compared the effectiveness of a diagnostic clinic, participation in a support group, and enrollment in a mathematics course. Sixty-nine female students participated in a three-hour diagnostic clinic as

part of a Math Anxiety Program in Continuing Education for Women at the University of Minnesota. After receiving a report of their mathematics performance and a recommendation for registering in one of three special mathematics classes, subjects then chose to enroll in one of the mathematics classes, enroll in a class and concurrently participate in a support group, or discontinue the program. Pretesting was in September; posttesting was in February, two weeks after the classes ended. Representativeness of the complete data sets is in question because posttesting data were completed by only 47 of the original 69 subjects (8 of the 22 women in the mathematics course, 11 of the 15 women who participated in both the course and the group, and 28 of the 32 women in the diagnostic clinic only group).

The multifaceted counseling support group met for seven weeks for one and one-half hours each week and included the following: cognitive restructuring, mathematics autobiography, diary, games and weekly goal setting, assertiveness for asking questions in class, and a brief introduction to desensitization relaxation exercises.

Results indicated that all three groups decreased significantly in MARS scores, with maximum improvement for subjects enrolled in the mathematics course and the counseling support group and minimum improvement for subjects in the diagnostic clinic only group. Again, the lack of a control group makes the results difficult to evaluate.

In 1975 Sheila Tobias (1978) and Robert Rosenbaum established the country's first Math (Anxiety) Clinic at Wesleyan University. After an interview with a clinic counselor, students with inadequate backgrounds in mathematics can take one of two special courses, algebra review or precalculus. A psychology laboratory is available as an option to the students enrolled in the courses. Auslander (1979), math teacher at the clinic, reported on attitude changes of participating students as measured by four Fennema-Sherman Scales (1976): mathematics anxiety, confidence in learning mathematics, usefulness of mathematics, and attitude toward success in mathematics. Auslander found the following after the 1977 courses: 1) total students showed a significant decrease in math anxiety, with a "distinct decrease" for women while the men showed little change. 2) There was a marked decrease in degree of usefulness ascribed to mathematics for men with a smaller decrease for women. 3) Pretesting showed significantly greater anxiety and less confidence among algebra students as compared to precalculus students. Posttesting showed no significant differences between the two. Precalculus students' anxiety had increased and confidence had decreased while algebra students' anxiety had decreased and their confidence increased.

Auslander suggested as possible reasons for the increase in anxiety among the precalculus students and the decrease among algebra students the following: the algebra

course was supportive and sensitive to students' needs, and students were reviewing material previously learned. The precalculus course was less supportive, and students were learning new material.

In 1978 the precalculus course was modified to include more class participation and to cover somewhat less material. Results showed 1) a significant decrease in students' anxiety with a "distinct decrease" for women and little change for men, 2) a significant increase in confidence for total students with greater increase for women than for men, 3) a marginally significant increase in the value placed on success in mathematics with somewhat more for women than for men, 4) the significantly higher levels of math anxiety found at pretesting among women decreased to nonsignificance at posttesting, 5) the precalculus students were significantly less anxious and more confident than the algebra students in both pre- and posttesting, and 6) there was no decrease in degree of usefulness ascribed to mathematics found at posttesting. Auslander concluded that the supportive atmosphere of the precalculus class which resulted in less anxiety, more confidence, and no decline in the degree of usefulness was "both healthier and more productive" (p. 20) and more than made up for the fact that somewhat less material was covered.

Serious methodological problems arise, however, in this study. There was no control group; performance measures would have been readily available but were not supplied;

and no data were reported on numbers of students or on any of the statistical analyses. The study does point out, nevertheless, that the atmosphere in a mathematics class appears to have a definite effect on anxiety and confidence levels. These levels have, in turn, been shown to have a measurable effect on cognitive performance. Revision of mathematical curricula according to the suggestions of Sawyer (1943, 1964), Gough (1954), Skemp (1971), Lazarus (1974), and Zacharias (1976) appears to be a fruitful area for future study.

In summary, the history of the literature of math anxiety is a relatively short one. Math anxiety has been shown to be a prevalent phenomenon on college campuses, but not enough is known from the existing empirical research about the nature of math anxiety, its causes, or its cures. Educators in mathematics have suggested that the fear of mathematics is the expected result of bad teaching, poorly written textbooks, and faulty beliefs and expectations. Sex-role socialization has made learning mathematics even more difficult for many women.

Math anxiety treatment strategies may be placed on a continuum from psychological intervention alone, to psychological intervention in combination with a math class, to a math class alone. Psychological interventions began, as did the early test anxiety studies, with behavior therapy strategies such as systematic desensitization. As a cognitive-attentional perspective of test anxiety has

found increasing empirical support, more emphasis has been placed on restructuring cognitive and attentional processes. Realization that both test and math anxiety are complex, multidimensional constructs must, in turn, lead to multi-faceted approaches which have more prospect of making lasting, significant changes.

Additional systematic investigations of more complex math anxiety treatments, both psychological and educational, are sorely needed (Richardson & Woolfolk, 1980; Tryon, 1980). Richardson and Woolfolk concluded their review by suggesting the pressing need for further investigations.

> Such efforts should include long-term follow-up concerning changes in anxiety, attitudes toward mathematics, educational and occupational choices, and possible generalized benefits to student's positive mental health or coping skills in other areas of living. Perhaps such research could most profitably emphasize the evaluation of ongoing counseling or educational programs in their natural environment, like the Wellesley and Wesleyan projects, rather than familiar, "one-shot" treatment studies that pit artificially truncated treatment procedures against each other and rarely investigate the longer-term durability of effects. (p. 285, 286)

CHAPTER THREE
METHOD

Subjects

Participants in this study were 50 students, 35 females and 15 males, who self-reported to the University Counseling Center in response to flyers announcing seven-session Math Confidence groups cosponsored by the Counseling Center and the Department of Mathematics. All students responding were scheduled for an initial individual screening interview. Students with severe psychological problems were referred for individual counseling. A few students applied who were confident of their mathematical ability and who were not anxious about mathematics. They were referred to math tutors and/or to study skills counseling. All treatment subjects were required to be learning math. For those students not enrolled in a mathematics, statistics, or other mathematics-based class, special arrangements were made with the students for regular, structured mathematics study. After Spring term, 1981, criteria for acceptance also included a minimum 2.00 grade point average as a means of limiting treatment to math deficient but otherwise academically competent students, the designated population for this study. Students in the two Spring, 1981, groups took the

Math Confidence Workshops as a special two-credit course through the College of Education.

Participants' grade point averages ranged from 1.79 to 3.96; mean GPA was 2.94 (S.D. = .65). Average age of subjects was 26 with a minimum age of 18 and a maximum of 55 (S.D. = 7.97). There were 43 Caucasians, 1 Black, 3 Spanish, and 3 "other." Table 1 presents the treatment subjects by group and sex. Due to students' class and work conflicts, it was not possible to assign the students to groups randomly.

Control group subjects were in three categories. Twenty subjects were undergraduate education majors enrolled in MAE 3810 (10 subjects) and MAE 3811 (10 subjects), Math for Elementary Schoolteachers I and II. The study was explained to students in these two courses, and the 20 subjects volunteered to participate in the study. Students in these classes were selected to control for the effects of being enrolled in a mathematics class during the designated treatment period.

The second and third groups were students participating in research to earn credit for an introductory psychology course. The second group of 34 students responded to a request for subjects to participate in a study investigating attitudes toward mathematics. These students were selected to serve as a nonanxious comparison group. The third group of 20 subjects responded to a request for subjects who had negative attitudes toward mathematics. Of the latter group,

Table 1

Math Confidence Treatment Group Subjects

Group	Male	Female	Total
1. Spring, 1982	5	3	8
2. Spring, 1982	2	6	8
3. Fall, 1981	4	7	11
4. Fall, 1981	3	6	9
5. Spring, 1981	0	5	5
6. Spring, 1981	1	8	9
TOTAL	15	35	50

12 indicated interest in participating in a Math Confidence Group. These 12 subjects were chosen to serve as a comparable mathanxious control group.

Control subjects' grade point averages ranged from 1.3 to 4.00; mean GPA was 2.82 (S.D. = .61). Average age of subjects was 20 with a minimum age of 18 and a maximum of 42 (S.D. = 4.04). There were 62 Caucasians, 1 Black, 2 Spanish, and 1 "other." Table 2 presents the control subjects by group and sex. All subjects, treatment and control, were volunteers.

Instruments

The Fennema-Sherman Mathematics Attitudes Scales (Fennema & Sherman, 1976) were used to assess six variables. These scales were designed for use with high school students and were adapted by Betz (1978) for use with college students. All items were responded to by students using a five-point Likert scale of (1) Strongly Disagree to (5) Strongly Agree. Scoring of all negatively worded items was reversed.

The Math Anxiety Scale (MAS) is designed to measure "feelings of anxiety, dread, nervousness, and associated bodily symptoms related to doing mathematics" (Fennema & Sherman, 1976, p. 4). Half of the ten items were positively worded, while the other half were negatively worded. Lower scores indicate higher levels of math anxiety; higher scores indicate more positive attitudes toward math, that

Table 2

Control Group Subjects

Group	Male	Female	Total
Psychology 1	14	20	34
Psychology 2	4	8	12
Math Classes	2	18	20
TOTAL	20	46	66

is, less math anxiety. Possible scores range from 10 to 50. A split-half reliability coefficient of .89 was found for the original Mathematics Anxiety Scale (Fennema & Sherman, 1976), while a reliability coefficient of .92 was obtained for the revised version used in this study. Correlations of MAS scores with math background (r = .30), performance on the SAT-M (r = .40), and a measure of confidence in learning mathematics (r = .84) provide evidence for its validity (Probert, Note 2).

The Confidence in Learning Mathematics Scale was designed to measure "confidence in one's ability to learn and to perform well on mathematical tasks" (Fennema & Sherman, 1976, p. 4). Possible scores range from 10 to 50. Higher scores on this scale are indicative of greater confidence in learning mathematics.

The Math as a Male Domain Scale measures "the degree to which students see mathematics as a male, neutral, or female domain." Attitudes are assessed on "(a) the relative ability of the sexes to perform in mathematics; (b) the masculinity/femininity of those who achieve well in mathematics; and (c) the appropriateness of this line of study for the two sexes" (Fennema & Sherman, 1976, p. 3). Possible scores range from 9 to 45. Higher scores indicate less tendency to view math as a male domain, less tendency to view males as innately better in math or math as a more appropriate field of study for males than for females.

"Students' beliefs about the usefulness of mathematics currently and in relationship to their future education, vocation, or other activities" (Fennema & Sherman, 1976, p. 5) were measured on the Mathematics Usefulness Scale. Possible scores range from 10 to 50. Higher scores indicate more positive attitudes toward the usefulness of mathematics.

The Effectance Motivation in Mathematics Scale was used to measure "effectance as applied to mathematics. The dimension ranges from lack of involvement in mathematics to active enjoyment and seeking of challenge" (Fennema & Sherman, 1976, p. 5). Possible scores range from 10 to 50. Higher scores indicate more active enjoyment of mathematics.

The subjects' perceptions of the attitudes of teachers were assessed using the Teacher Scale of the Fennema-Sherman Mathematics Attitude Scales. Possible scores range from 10 to 50. Higher scores indicate perception of more positive teachers' attitudes.

The six Fennema-Sherman Mathematics Attitudes Scales are contained in Appendices A 1-6.

The Test Anxiety Inventory (TAI: Spielberger, Gonzales, Taylor, Anton, Algaze, Ross, & Westberry, 1980) consists of 20 statements describing feelings and reactions that can occur when taking tests. Subjects responded to each item using a four-point scale of (1) Almost Never, (2) Sometimes, (3) Often, and (4) Almost Always. Scores may range from 20 to 80, and higher scores indicate higher levels of

anxiety. Correlations between the TAI and Sarason's (1958) Test Anxiety Scale range from .85 to .95, and the TAI provides subscales for Worry and Emotionality components of test anxiety.

The A-Trait Scale of the State-Trait Anxiety Inventory (STAI: Spielberger, Gorsuch, & Lushene, 1970) was used to measure "relatively stable individual differences in anxiety proneness" (p. 3). The students were asked to respond to each item using a four-point scale with response categories identical to those used on the TAI. Total scores range from a minimum of 20 to a maximum of 80. The scoring weights were reversed so that higher scores indicate higher levels of trait anxiety. The above two scales are contained in Appendices B 1-2.

Treatment

The experimental design was a repeated-measures paradigm involving pretreatment and posttreatment assessment of variables on self-report measures. The purpose of the study was to determine the efficacy of the multidimensional group treatment strategy. Pre- to posttreatment change was investigated on the following scales:

1) Math Anxiety
2) Confidence in Learning Mathematics
3) Math as a Male Domain
4) Usefulness of Mathematics
5) Effectance Motivation in Mathematics
6) Test Anxiety
7) Worry component of test anxiety
8) Emotionality component of test anxiety.

It was anticipated that there would be significant pre- to posttreatment improvement on all scales or, in cases of nonsignificant posttest improvement, that the posttreatment scores would be comparable to those of the nonanxious comparison group, the Psychology I control group, or the math classes control group. It was also anticipated that there would be significant improvement in treatment subjects' perception of their ability in mathematics. No component of the intervention was aimed at changing attitudes toward teachers. No change on the Teacher Scale, therefore, was predicted nor was a change predicted for the A-Trait Scale, a measure of relatively stable anxiety. The purpose of the follow-up study was to assess the predicted maintenance effects of the anticipated treatment improvement.

Data were collected from treatment subjects (a) just prior to an initial screening interview during approximately the first three to four weeks of the term and (b) during the last session of the treatment. The Fennema-Sherman Mathematics Attitudes Scales and the Spielberger Anxiety Inventories were administered both pre- and posttreatment. Mathematics background information (see Appendix C) was collected pretreatment. The initial screening interview, which included a discussion of the background information, was conducted by the principal investigator.

The Fennema-Sherman Mathematics Attitudes Scales and the Spielberger Anxiety Inventories were administered to control subjects during approximately the same time periods

as pre- and posttreatment data were collected from treatment subjects. Data were collected from the Math for Elementary Schoolteachers classes in the Spring of 1981. Data from the psychology students, collected during Spring term, 1982, included pre- and post-testing general information (see Appendix D). Follow-up questionnaires (see Appendix F) were mailed to all treatment subjects in October, 1982, approximately six months, one year, and one and one-half years, respectively, after the Spring, 1982, Fall, 1981, and Spring, 1981, treatment interventions.

Therapists

A male Counseling Center staff psychologist and the principal investigator served as therapists for two of the treatments. A female, advanced graduate student in Counselor Education, was cotherapist for another treatment group. The remaining three groups were led by the principal investigator.

General Procedure

All groups met for seven weekly, two-hour sessions and followed essentially the same treatment procedures.

Rationale and Goals. Subjects were given a rationale that emphasized that 1) they had the intelligence to learn mathematics; 2) their self-defeating beliefs, self-statements, expectations, and behaviors directly influenced their anxiety and other negative emotions and resulted in

their poor performance in mathematics; 3) they would be self-scientists, learning to understand their own problems (assessment), devising their individual treatment plans, carrying out the plans, and reassessing as they progressed; and 4) their treatment plans would incorporate coping skills which they could learn and use effectively. Overall goals would be to 1) replace their maladaptive attitudes, beliefs, and behaviors with more beneficial ones; 2) manage their anxiety more effectively; 3) gain confidence in their mathematical intuition, reasoning powers, and ability to learn mathematics; 4) focus more on doing math and less on self-evaluation; 5) learn to have a higher frustration tolerance for making mistakes and for not solving a problem immediately; and 6) gain control, to stop feeling helpless, and to use already established academic coping behaviors. The entire process would involve a self-image change.

Format. In general, each session began with group "rounds." Discussions included homework assignments, improvements made in coping behaviors, and identification of problem areas. Discussions were informal, and participants were encouraged to acquire facilitative interaction skills.

Observational Learning (Modeling). A group setting made it possible for students to meet other intelligent adults who have had anxiety and negative feelings about math and about themselves as learners of math. All three therapists recounted personal experiences of math anxiety and how they had been successful in managing their anxiety

and in learning mathematics. The film, Math Anxiety: We Beat It, So Can You!, provided many additional examples of people of all ages overcoming math anxiety. Inasmuch as modeling is more effective if the subjects observe someone they perceived as a peer (Bandura, 1969), male and female students from previous Math Confidence groups were invited to the first session of each group to recount their experiences and to answer questions. Finally, group members provided additional sources of positive reinforcement and concern for the improved performance of fellow members. To enhance this effect, members were encouraged to telephone each other between sessions and to think of each other during scheduled math exams.

Homework. Homework assignments were an integral part of the treatment. Each week subjects received an assignment based on the concepts and techniques discussed during the treatment session.

Session Outlines. Outlines of the seven sessions may be found in Appendix E.

CHAPTER FOUR
RESULTS

These data were analyzed by repeated measures analyses of variance. An interaction was found in the analysis between groups on all scales with the exception of the trait anxiety measure. These inconsistent levels of change precluded combining the six intervention groups, and as a consequence they were examined separately. Duncan's Multiple Range Tests (see Appendix H) illustrate the different patterns of significance pretest and posttest.

The efficacy of the multidimensional group intervention was determined by pre- and posttreatment measures on several scales.

Fennema-Sherman Mathematics Attitudes Scales

Table 3 presents the comparison of means of Math Anxiety scores. These results indicated that all treatment groups except Treatment 5 (n = 5) showed significant pre- to posttreatment differences. On a closely related measure, the Confidence Scale (see Table 4), the improvement of all six treatment groups reached significance.

Pre- to posttherapy mean score improvement reached significance on the Math as a Male Domain Scale for four of the six treatment groups as shown in Table 5, while

Table 3

Comparison Between Pretreatment and Posttreatment Math Anxiety Scores, by Group

		Pretreatment		Posttreatment		
	n	M	SD	M	SD	F
Treatment						
1	8	16.88	4.36	33.75	6.52	68.48*
2	8	18.38	4.24	32.63	6.05	66.31*
3	11	18.73	8.49	29.45	8.94	30.56*
4	9	18.89	5.95	34.45	8.87	28.27*
5	5	16.40	6.35	22.40	7.54	6.21
6	9	14.11	5.62	27.89	5.19	50.70*
Control						
Psychology 1	34	36.18	8.26	36.24	7.52	0.01
Psychology 2	12	25.17	11.26	23.42	11.37	3.60
Math Classes	20	30.25	10.07	30.90	10.15	0.71

Note. Possible socres range from 10 to 50. Lower scores indicate higher levels of math anxiety.

*$p < .001$.

Table 4

Comparison Between Pretreatment and Posttreatment Confidence Scores, by Group

		Pretreatment		Posttreatment		
	n	M	SD	M	SD	F
Treatment						
1	8	22.88	4.42	34.50	5.43	51.88***
2	8	24.13	2.70	34.75	4.90	27.74***
3	11	23.73	10.10	34.10	9.73	22.19***
4	9	23.67	6.56	37.33	8.26	14.31**
5	5	21.40	10.90	29.20	6.69	8.77*
6	9	18.67	5.68	29.78	5.21	84.75***
Control						
Psychology 1	34	38.74	8.42	38.94	7.88	.12
Psychology 2	12	25.92	8.94	24.83	8.85	3.04
Math Classes	20	32.75	9.62	32.25	10.17	.56

Note. Possible scores range from 10 to 50. Higher scores are indicative of greater confidence in learning mathematics.

*$p < .05$.

**$p < .01$.

***$p < .001$.

Table 5

Comparison Between Pretreatment and Posttreatment Math as a Male Domain Scores, by Group

Group	n	Pretreatment M	Pretreatment SD	Posttreatment M	Posttreatment SD	F
Treatment						
1	8	35.75	7.42	39.25	4.95	5.81*
2	8	30.00	4.57	36.63	5.21	10.60**
3	11	35.27	7.36	40.00	4.73	13.95***
4	9	33.89	7.54	39.33	5.12	4.58
5	5	31.40	8.88	33.60	6.43	1.12
6	9	29.22	5.59	35.33	4.58	33.24***
Control						
Psychology 1	34	37.27	6.37	36.50	7.19	1.15
Psychology 2	12	38.50	5.87	37.00	5.83	1.76
Math Classes	20	36.85	5.99	36.60	5.70	0.06

Note. Possible scores range from 9 to 45. Higher scores indicate less tendency to view math as a male domain.

*$p < .05$.

**$p < .01$.

***$p < .001$.

three groups showed significant differences on the Usefulness Scale (see Table 6). The levels of posttest improvement for Group 4 on the Math as a Male Domain Scale and for Groups 4 and 6 on the Usefulness Scale, while not statistically significant, were actually higher than any of the control group scores.

The levels of improvement of five groups on the Effectance Motivation Scale were statistically significant. These results are presented in Table 7. No component of the intervention strategy was aimed at changing attitudes toward teachers, and, as anticipated there were no significant differences in the pre- to posttreatment scores on the Perception of Attitudes of Teachers Scale (see Table 8). Control subjects did not show any significant changes from pre- to posttesting on any of the Fennema-Sherman Scales.

Spielberger Trait and Test Anxiety Inventories

There were no significant differences among the pretest or the posttest means of the six treatment groups and the three control groups on the A-Trait Anxiety Inventory (see Appendix H-7). Additionally, none of the differences between pretreatment and posttreatment means reached significance, as shown in Table 9. Inasmuch as the A-Trait scale by definition measures "relatively stable individual differences in anxiety proneness" (Spielberger, Gorsuch, and Lushene, 1970, p. 3), no changes in trait anxiety were predicted.

Table 6

Comparison Between Pretreatment and Posttreatment Usefulness Scores, by Group

Group	n	Pretreatment M	Pretreatment SD	Posttreatment M	Posttreatment SD	F
Treatment						
1	8	34.88	3.04	43.00	5.35	17.20**
2	8	33.88	4.49	39.63	3.78	8.36*
3	11	32.45	12.19	39.36	7.50	12.42*
4	9	39.00	4.69	41.78	4.29	2.24
5	5	32.80	8.04	36.60	4.45	2.24
6	9	38.11	3.14	40.44	5.22	2.58
Control						
Psychology 1	34	40.15	6.87	39.68	6.62	0.38
Psychology 2	12	39.17	5.51	38.42	5.79	.46
Math Classes	20	39.70	4.93	39.70	5.47	.00

Note. Possible scores range from 10 to 50. Higher scores indicate more positive attitudes toward the usefulness of mathematics.

*$p < .01$.

**$p < .001$.

Table 7

Comparison Between Pretreatment and Posttreatment Effectance Motivation Scores, by Group

Group	n	Pretreatment M	Pretreatment SD	Posttreatment M	Posttreatment SD	F
Treatment						
1	8	19.50	3.51	30.50	5.70	33.79*
2	8	23.38	5.29	31.88	3.72	20.43*
3	11	25.00	9.09	31.00	9.91	20.20*
4	9	27.67	5.90	35.33	7.62	23.25*
5	5	21.20	8.23	25.00	7.11	4.75
6	9	21.78	9.48	29.11	7.91	26.52*
Control						
Psychology 1	34	31.38	9.10	31.24	9.20	.06
Psychology 2	12	25.91	7.62	26.00	6.33	.01
Math Classes	20	27.00	7.17	27.55	7.83	.24

Note. Possible scores range from 10 to 50. Higher scores indicate more active enjoyment of mathematics.

*$p < .001$.

Table 8

Comparison Between Pretreatment and Posttreatment Perception of Attitudes of Teachers Scores, by Group

Group	n	Pretreatment M	Pretreatment SD	Posttreatment M	Posttreatment SD	F
Treatment						
1	8	25.13	7.80	25.13	6.83	.00
2	8	30.25	5.97	28.88	5.54	.29
3	11	24.36	10.16	25.64	10.83	.52
4	9	28.22	5.33	29.00	5.45	.24
5	5	23.40	8.47	25.20	10.78	.78
6	9	22.56	9.51	23.22	5.95	.10
Control						
Psychology 1	34	36.41	6.43	36.38	6.54	.00
Psychology 2	12	28.00	9.34	28.83	8.47	.98
Math Classes	20	31.95	5.59	31.15	6.92	.34

Note. Possible scores range from 10 to 50. Higher scores indicate perception of more positive teachers' attitudes.

Table 9

Comparison Between Pretreatment and Posttreatment A-Trait Anxiety Scores, by Group

		Pretreatment		Posttreatment		
Group	n	M	SD	M	SD	F
Treatment						
1	8	42.13	11.91	37.50	10.41	1.64
2	8	40.88	7.62	37.25	7.67	2.54
3	11	43.73	14.79	37.35	11.31	9.69
4	9	44.00	9.80	37.67	8.65	3.22
5	5	41.00	5.66	40.80	4.82	.05
6	9	42.56	10.50	39.22	8.54	2.52
Control						
Psychology 1	34	36.15	7.26	36.15	7.30	.00
Psychology 2	12	40.92	9.17	44.25	12.11	4.33
Math Classes	20	37.70	6.70	37.55	7.22	.02

Note. Possible scores range from 20 to 80. Higher scores indicate higher levels of trait anxiety.

There were significant differences, however, between pretreatment and posttreatment test anxiety scores (see Table 10). All treatment groups except Treatment 5 showed significantly lower posttest levels of test anxiety. No significant changes were shown by control groups.

On the comparison of the Worry component of test anxiety between pre- and posttherapy means, there was a statistically significant positive change for all intervention groups. No significant changes were found for control groups. Groups 1, 2, 3, 4, and 6 showed significant improvement on the emotionality measure. Although Group 5 showed an average improvement in scores of 1.6, it was not statistically significant, while a mean score improvement of .94 for Psychology 1 control group was significant. This was, in part, due to the relatively greater n of the control group. Nonsignificant F ratios were found for the other two control groups.

Pearson product-moment correlation coefficients were calculated to describe the degree of relationship among pretreatment scores of the 50 treatment subjects and of the 66 control subjects on the Mathematics Anxiety Scale, the A-Trait scale of the State-Trait Anxiety Inventory, and the total score, Emotionality score, and Worry score of the Test Anxiety Inventory. These relationships are shown in Table 13 for treatment subjects and in Table 14 for control subjects. For treatment subjects no statistically significant relationship was found between math and trait anxiety.

Table 10

Comparison Between Pretreatment and Posttreatment Test Anxiety Scores, by Group

		Pretreatment		Posttreatment		
Group	n	M	SD	M	SD	F
Treatment						
1	8	48.88	11.68	31.63	6.71	13.53*
2	8	46.00	12.02	35.75	11.41	12.27*
3	11	51.91	19.31	42.45	15.24	11.14*
4	9	54.33	15.50	36.11	13.57	9.92*
5	5	56.60	11.65	48.60	7.83	4.48
6	9	53.67	13.47	41.00	7.56	10.22*
Control						
Psychology 1	34	35.88	9.77	33.82	8.89	5.01
Psychology 2	12	52.50	13.81	50.67	13.74	.91
Math Classes	20	42.65	12.93	42.65	13.54	.00

Note. Scores may range from 20 to 80. Higher scores indicate higher levels of test anxiety.

*$p < .01$.

Table 11

Comparison Between Pretreatment and Posttreatment Test Anxiety Scores, Worry Component, by Group

Group	n	Pretreatment M	Pretreatment SD	Posttreatment M	Posttreatment SD	F
Treatment						
1	8	17.37	5.53	12.25	2.92	6.11*
2	8	16.87	3.76	13.88	3.83	22.91***
3	11	19.36	8.39	16.64	6.64	4.64*
4	9	20.67	7.16	14.22	5.04	6.85*
5	5	22.40	4.28	18.00	4.18	7.87*
6	9	20.00	5.41	15.11	3.14	7.52**
Control						
Psychology 1	34	13.47	3.55	12.74	3.38	2.99
Psychology 2	12	19.67	5.61	18.66	5.52	1.18
Math Classes	20	15.85	5.48	15.65	5.39	.11

Note. Possible scores range from 8 to 32. Higher scores indicate higher levels of worry.

*$p < .05$.

**$p < .01$.

***$p < .001$.

Table 12

Comparison Between Pretreatment and Posttreatment Test Anxiety Scores, Emotionality Component, by Group

Group	n	Pretreatment M	Pretreatment SD	Posttreatment M	Posttreatment SD	F
Treatment						
1	8	20.75	5.39	13.25	2.76	9.66**
2	8	18.75	5.50	14.88	4.76	6.14*
3	11	21.73	7.30	17.09	5.68	25.01***
4	9	21.78	5.87	14.33	5.89	10.90**
5	5	22.20	5.36	20.60	2.61	.90
6	9	21.89	5.84	16.89	3.41	7.69**
Control						
Psychology 1	34	15.26	4.33	14.32	3.80	4.18*
Psychology 2	12	21.33	5.26	20.92	5.40	.15
Math Classes	20	18.15	5.23	18.20	5.70	.01

Note. Possible scores range from 8 to 32. Higher scores indicate higher levels of emotionality.

*$p < .05$.

**$p < .01$.

***$p < .001$.

Table 13

Correlations Among Math Anxiety, Trait Anxiety, and Test Anxiety in Treatment Subjects

Scale	2	3	4	5
1. Math anxiety	-.15	-.51**	-.45**	-.53**
2. Trait anxiety[a]		.36*	.37*	.36*
Test anxiety[b]				
3. Total score			.96**	.95**
4. Emotionality				.84**
5. Worry				--

Note. All correlations are based on n = 50.

[a]A-Trait Scale of State-Trait Anxiety Inventory.

[b]Test Anxiety Inventory.

*$p < .01$.

**$p < .001$.

Table 14

Correlations Among Math Anxiety, Trait Anxiety, and Test Anxiety in Control Subjects

Scale	2	3	4	5
1. Math Anxiety	-.52*	-.73*	-.72*	-.69*
2. Trait Anxiety		.70*	.67*	.67*
3. Total			.96*	.96*
4. Emotionality				.85*

Note. All correlations are based on n = 66.

[a]A-Trait Scale of State-Trait Anxiety Inventory.

[b]Test Anxiety Inventory.

*$p < .001$.

Higher levels of math anxiety (as indicated by lower scores on the Math Anxiety Scale) were related to higher levels of test anxiety and both Emotionality and Worry components of test anxiety (as indicated by higher scores on the TAI scale). A moderately significant relationship was found between trait and test anxiety, and trait and the Emotionality and Worry components of test anxiety. Strong relationships, as expected, were found among test anxiety and Emotionality and Worry.

For control subjects a statistically significant relationship (-.52) was found between math and trait anxiety, and strong relationships were found for the remaining correlations.

Self-Report Math Ability Ratings

Subjects in treatment groups and the two psychology control groups were asked pre- and posttreatment to rate their own math ability (see Table 15). The subjects' perception of improvement in their ability in mathematics was statistically significant for all six intervention groups. There was no change in means for either of the control groups.

Thus it can be seen that, with the exception of Treatment Group 5, all groups met the anticipated criteria for improvement, i.e., significant pre- to posttreatment improvement on designated scales, or, in cases of nonsignificant posttest improvement, that the posttreatment scores

Table 15

Comparison Between Pretreatment and Posttreatment Self-Report Math Ability Ratings, by Group

		Pretreatment		Posttreatment		
Group	n	M	SD	M	SD	F
Treatment						
1	8	2.63	0.74	4.50	1.41	22.18**
2	8	3.13	0.64	4.75	1.16	25.17**
3	11	2.45	1.37	4.73	1.74	46.64**
4	9	2.56	1.24	5.00	1.41	30.25**
5	5	2.75	0.50	4.25	0.96	10.29*
6	9	2.00	1.12	4.11	0.93	19.00**
Control						
Psychology 1	34	5.03	1.09	5.00	1.04	.20
Psychology 2	12	3.83	1.03	3.67	1.15	2.20

Note. The following scale was used in the self-report math ability ratings: (1) Terrible, (2) Very Poor, (3) Poor, (4) Average, (5) Good, (6) Very Good, (7) Excellent.

*$p < .05$.

**$p < .001$.

were comparable to those of the nonaxious comparison group, the Psychology I control group, or the math classes control group. All six groups showed significant pre- to post-treatment improvement on the Confidence in Learning Mathematics Scale, the Worry component of test anxiety, and in subjects' perception of their ability in mathematics. Significant pre- to posttreatment improvement was found for all but Group 5 on the Math Anxiety, Effectance Motivation, Test Anxiety, and Emotionality component of test anxiety scales. For the Math as a Male Domain and Usefulness of Mathematics scales all but Group 5 met the criteria of either significant pre- to posttest improvement or had higher posttest scores than any of the control groups.

Analysis of Variance by Sex, Group and Time

Although it was not a part of the original purpose of the study, an analysis of variance by sex, group (control and treatment), and time was performed after the original analyses. These results may be found in Appendix I. Significant main effects were found for male-female differences on the Math Anxiety, Confidence, and Teacher Scales, with males being found with less math anxiety, greater confidence in their ability to learn mathematics, and more positive perceptions of teachers' attitudes toward them as learners of mathematics. Significant male-female differences were not found for Math as a Male Domain, Usefulness,

Effectance Motivation, Trait Anxiety, Test Anxiety, Worry, or Emotionality.

Significant differences were found for time (pre- to posttreatment) and for group x time interaction for all scales except Teacher. On the Usefulness of Mathematics Scale there was also a significant interaction between group and sex as well as between group and sex and time.

Further analysis of the group x time interaction found that at pretest control subjects (males and females) were significantly different ($p < .001$) from treatment subjects (males and females) on all 10 scales. At posttest significant differences were found between treatment and control subjects only on the Teacher scale. Pre- and posttest F values may be found in Appendix I-11.

When the interactions on the Usefulness of Mathematics scale were examined, it was found that the control males had significantly higher scores ($p < .01$) than the treatment males did at pretest. Treatment males, however, were higher at posttest, but the difference was not significant. Similar results were found for females, with control females having significantly higher ($p < .01$) scores at pretest, and treatment females having nonsignificantly higher scores at posttest. Treatment females were nonsignificantly higher than treatment males at pretest. Treatment males were significantly higher than treatment females at posttest ($p < .05$). The higher scores of control males when compared to control females both pre- and posttest were not significantly different.

Follow-up Questionnaire

Out of 50 treatment subjects, 42 (84 percent) responded to the follow-up questionnaire which was mailed during Fall term, 1982. It was not possible to locate three of the subjects whose questionnaires were returned by the post office from their last known address. Hence, only five of the subjects who received questionnaires failed to return them.

Results from the follow-up questionnaires are presented in Tables 16 through 24. These findings provide strong evidence of the subjects' self-reported continued improvement in several areas, including performance in math courses, ability to learn and use math, decrease in math and test anxiety, and in other specific behavioral dimensions addressed in the math group up to 1 1/2 years after the intervention program. Additionally, it appeared there was also supporting evidence that math anxiety was to a large extent no longer a negative influence in their life decisions.

Table 16

Subjects' Perception of Extent to Which Educational, Career, or Other Life Decisions Were Positively Influenced by the Math Group

Spring, 1981[a]		Fall, 1981[b]		Spring, 1982[c]		Total[d]	
M	SD	M	SD	M	SD	M	SD
4.89	1.96	5.63	1.01	4.79	1.12	5.19	1.33

Note. Subjects responded using a seven-point scale from (1) very small extent to (7) very large extent.

[a] n = 9 in 1 1/2 year follow-up.

[b] n = 19 in 1 year follow-up.

[c] n = 14 in 6 month follow-up.

[d] n = 42.

Table 17

Subjects' Perception of Extent to Which Life Decisions Had Been/Will Be Negatively Influenced by Math Anxiety/Avoidance After Math Group

Spring, 1981[a]		Fall, 1981[b]		Spring, 1982[c]		Total[d]	
M	SD	M	SD	M	SD	M	SD
2.22	1.48	1.95	1.35	2.43	1.09	2.17	1.29

Note. Subjects responded using a seven-point scale from (1) very small extent to (7) very large extent.

[a] n = 9 in 1 1/2 year follow-up.

[b] n = 19 in 1 year follow-up.

[c] n = 14 in 6 month follow-up.

[d] n = 42.

Table 18

Subjects' Perception of Extent to Which Math Anxiety Clinic and the Math Groups Should Be Continued at the University

Spring, 1981[a]		Fall, 1981[b]		Spring, 1982[c]		Total[d]	
M	SD	M	SD	M	SD	M	SD
6.11	1.45	6.68	.95	6.36	.84	6.45	1.04

Note. Subjects responded using a seven-point scale from (1) not at all important to (7) extremely important.

[a] n = 9 in 1 1/2 year follow-up.

[b] n = 19 in 1 year follow-up.

[c] n = 14 in 6 month follow-up.

[d] n = 42.

Table 19

Subjects' Perception of Extent to Which Math Group Was Important Compared to Other Activities at the University (Classes, Workshops, Other Academic Activities)

Spring, 1981[a]		Fall, 1981[b]		Spring, 1982[c]		Total[d]	
M	SD	M	SD	M	SD	M	SD
3.44	1.33	4.53	.96	4.36	.75	4.24	1.05

Note. Subjects responded using a five-point scale from (1) bottom 20 percent to (5) top 20 percent.

[a] n = 9 in 1 1/2 year follow-up.

[b] n = 19 in 1 year follow-up.

[c] n = 14 in 6 month follow-up.

[d] n = 42.

Table 20

Subjects' Perception of the Extent to Which the Math Group Improved Their Academic Performance

	Spring, 1981[a]		Fall, 1981[b]		Spring, 1982[c]		Total[d]	
	M	SD	M	SD	M	SD	M	SD
Math or Math-related Courses	5.86	1.86	5.94	1.03	6.10	.74	5.97	1.14
Other Courses	3.78	1.86	4.84	1.80	4.93	1.00	4.64	1.62
Everyday Life	4.67	2.06	5.21	1.51	4.50	.94	4.86	1.49

Note. Subjects responded using a seven-point scale from (1) very small extent to (7) very large extent.

[a] n = 9 in 1 1/2 year follow-up.

[b] n = 19 in 1 year follow-up.

[c] n = 14 in 6 month follow-up.

[d] n = 42.

Table 21

Subjects' Perception of Their Level of Math Anxiety

	Spring, 1981[a]		Fall, 1981[b]		Spring, 1982[c]		Total[d]	
	M	SD	M	SD	M	SD	M	SD
Before the Group	6.33	1.0	6.42	.90	6.21	.70	6.33	.85
After the Group	3.22	1.2	2.74	1.5	3.07	1.07	2.95	1.13
Presently	2.89	.93	2.53	1.2	3.36	1.45	2.88	1.23

Note. Subjects responded using seven-point scale from (1) no anxiety to (7) very high anxiety.

[a] n = 9 in 1 1/2 year follow-up.

[b] n = 19 in 1 year follow-up.

[c] n = 14 in 6 month follow-up.

[d] n = 42.

Table 22

Subjects' Perception of Their Level of Ability to Learn and Use Math

	Spring, 1981[a]		Fall, 1981[b]		Spring, 1982[c]		Total[d]	
	M	SD	M	SD	M	SD	M	SD
Before the Group	2.11	1.36	2.53	1.22	2.57	.85	2.45	1.13
After the Group	5.00	1.0	5.47	.96	5.36	.63	5.33	.87
Presently	5.11	.93	5.53	.84	5.07	1.00	5.29	.92

Note. Subjects responded using seven-point scale from (1) very low (terrible) to (4) average to (7) very high (excellent).

[a] n = 9 in 1 1/2 year follow-up.

[b] n = 19 in 1 year follow-up.

[c] n = 14 in 6 month follow-up.

[d] n = 42.

Table 23

Subjects' Perception of Their Level of Test Anxiety

	Spring, 1981[a]		Fall, 1981[b]		Spring, 1982[c]		Total[d]	
	M	SD	M	SD	M	SD	M	SD
Before the Group	6.11	1.05	5.68	1.53	5.08	1.5	5.59	1.45
After the Group	3.33	1.3	3.21	1.51	3.15	1.07	3.22	1.31
Presently	3.00	1.6	3.37	1.57	3.08	1.04	3.20	1.40

Note. Subjects responded using a seven-point scale from (1) no anxiety to (7) very high anxiety.

[a] n = 9 in 1 1/2 year follow-up.

[b] n = 19 in 1 year follow-up.

[c] n = 14 in 6 month follow-up.

[d] n = 42.

Table 24

Subjects' Perception of Extent to Which Positive Change Was Made in Specific Behavioral Dimensions Addressed in Math Group

	Spring, 1981[a]		Fall, 1981[b]		Spring, 1982[c]		Total[d]	
	M	SD	M	SD	M	SD	M	SD
Extent to which self-talk has become less negative, more positive.	5.44	.88	5.26	1.28	5.14	1.10	5.26	1.13
Extent to which have become less nonassertive/more assertive	5.00	1.12	4.09	1.52	4.64	1.15	4.83	1.30
Extent to which have become less aggressive/more assertive	4.17	.75	4.63	1.34	4.38	.87	4.47	1.11
Extent to which have avoided math less	4.78	1.72	5.42	1.71	5.00	1.04	5.14	1.51
Extent to which have better study habits	4.56	.88	5.21	1.22	4.36	1.82	4.79	1.42
Extent to which better at time management	4.56	1.01	4.58	1.50	4.14	1.79	4.43	1.50

Table 24 (continued)

	Spring, 1981[a]		Fall, 1981[b]		Spring, 1982[c]		Total[d]	
	M	SD	M	SD	M	SD	M	SD
Extent to which do less stereotyping of mathematicians and those who do well in math	5.44	1.67	6.11	1.60	5.50	1.09	5.76	1.46
Extent to which have better self-image	5.78	.67	5.68	1.70	4.86	.86	5.43	1.33
Extent to which use anxiety as a cue to relax	5.56	1.01	5.16	1.71	4.79	1.31	5.12	1.45

Note. Subjects responded to each item using a seven-point scale from (1) very small extent to (7) very large extent.

[a] n = 9 in 1 1/2 year follow-up.

[b] n = 19 in 1 year follow-up.

[c] n = 14 in 6 month follow-up.

[d] n = 42.

CHAPTER FIVE
DISCUSSION

This chapter is divided into the following sections: 1) summary and interpretation of the results of the study, 2) implications of the results, and 3) future directions for research.

Summary and Interpretation of Results

The results of this study clearly support the efficacy of Math Confidence Workshops as a multidimensional group intervention strategy to help students gain confidence in their ability to learn and use mathematics and to reduce their math anxiety.

Perhaps the strongest support for this conclusion comes from the significant results on the Confidence in Learning Mathematics measure which includes such statements as "I am sure I could do advanced work in mathematics," "I have the ability to get good grades in math courses," and "I think I could handle more difficult mathematics." All six treatment groups showed statistically significant pre- to posttreatment improvement differences when compared to control groups.

Higher levels on the Confidence Scale have been shown to be significantly related to higher levels of performance

(Probert, Note 2), for example in comparisons with SAT-Math scores (r = .50, p < .001) and grades in math classes (r = .29, p < .01). In the same study, results of a multiple regression analysis showed that the confidence score was a statistically significant predictor of grades in a math course (F = 4.39, p < .01).

The importance of this variable was further shown in a longitudinal study by Sherman (1981) who found that by far the most important factor related to continuation in courses of theoretical mathematics for males was Confidence in Learning Mathematics. This variable had a stronger weight than any of the cognitive variables--mathematics achievement, spatial visualization, general ability, and verbal skill. For females in Sherman's study, Confidence in Learning Mathematics was found to be second in importance only to perceived Usefulness of Mathematics among the affective variables.

Further support for the effectiveness of the intervention strategy was shown by the students' perception of their own ability in mathematics. All six intervention groups showed statistically significant posttest improvement on this variable when compared to controls. Pretreatment average ratings were from "very poor" to "poor" for treatment groups. Posttreatment mean ratings were from above average to "good." The two psychology control groups showed a slight but insignificant tendency to lower their perception of their math ability. Posttest mean ratings were

"good" for the Psychology 1 control group and below average for the Psychology 2 control group.

How students perceive themselves as learners of mathematics is part of their self-concept. It has been suggested that it is more difficult to change self-concepts than attitudes, but that self-concept change is imperative for long-lasting effects.

> Those who would effect change in attitudes, values, behavior, or roles are necessarily concerned with a change in the self-concept, for it is assumed here that unless a change in the self-concept is achieved which is congruent with changes at lower levels in the hierarchy, the lower level change is likely to be reversed and the organism returned to the initial state of equilibrium. (Ziller, 1973, p. 174)

Additional evidence for long-lasting self-concept change came from the follow-up study in which it was found that subjects perceived to a large extent that they had "a better self-image."

Before examining additional positive findings, it seems important at this point in the discussion to look at the results in relation to Treatment Group 5. While change in the predicted direction was found for Group 5 on all pertinent measures (i.e., all except Perception of Teachers' Attitudes and A-Trait anxiety), those changes reached significance only on the Confidence in Learning Mathematics Scale, the Worry component of the Test Anxiety Scale, and the Self-Report Math Ability Ratings. It was

the only group which failed to meet the anticipated improvement criteria for all of the designated scales. What was it about this group that was different from other groups?

To begin with, an important factor was the size (n = 5) of Group 5. The original conception of the study was that all groups would be combined and compared to control groups (n = 34, 20, and 12, respectively). When this combined grouping became statistically inappropriate, one result was that a treatment group of five would necessarily be penalized in a statistical analysis because of its relatively fewer degrees of freedom, especially when compared to a group of 34 subjects. For example, the Psychology 1 Control Group had a statistically significant pre- to posttest change on the Emotionality component of test anxiety, but this difference was in fact of less magnitude than the pre- to posttest change observed for Treatment Group 5, and the latter change was statistically insignificant.

The average GPA of Group 5 was 2.10. Three of the five subjects in Group 5 had GPA's below 2.00 (i.e., 1.8, 1.8, and 1.9). The next lowest mean GPA was Group 6 at 2.85. The group leaders were struck by the apparent lack of motivation and academic skill demonstrated by Group 5 relative to the other treatment groups. This group did not appear to manifest established "academic coping behaviors" in areas other than mathematics and raised the question

as to whether the group was truly experiencing math anxiety rather than a general academic incompetence.

The criteria for selection in the present study were much less stringent than those in the three studies by Suinn and his associates (Richardson & Suinn, 1973; Suinn, Edie, & Spinell, 1970; Suinn & Richardson, 1971) reviewed earlier. Their highly selective method eliminated subjects for "lack of ability, inadequate background in mathematics, lack of motivation, or if he gave evidence of severe psychological disturbance" (Richardson & Suinn, 1973, p. 213). Additionally, "students were not taken whose anxiety seemed to be primarily connected with test-taking in general" (p. 213).

As a result of working with Group 5, the group leaders felt that a minimal demonstration of academic coping behaviors should be a 2.0 GPA. And, as a consequence of the changed criteria for acceptance, Group 5 will be considered an atypical group in this study, and, in one sense, removed from further discussion. Generalizability from the results of other groups in this study should be extended only to students who are academically competent to a minimum 2.00 GPA in subjects other than mathematics.

In regard to generalizability, an important variable in this study is the Math Anxiety measure. The pre- to posttest mean improvement of the treatment subjects on this scale reached statistical significance for all groups except Group 5. Inspection of the data reveals that the

posttreatment mean scores (omitting Group 5's 22.4) were 27.9, 29.5, 32.6, 33.8, 34.5. (Higher scores indicate more positive attitudes toward mathematics.) These scores compare favorably with those of the control groups, Psychology 2 ($\underline{M}$ = 23.4) and the Math Classes ($\underline{M}$ = 30.9), and also with the scores found by Betz (1978) in another study of college students. Betz reported the following math anxiety scores: students in a Math 1 class ($\underline{M}$ = 26.9), a Math 2 class ($\underline{M}$ = 31.6), a Psychology 1 class ($\underline{M}$ = 31.1), for a total mean score of 30.6. It should be noted that the posttest mean Math Anxiety scores of three of the treatment groups actually surpass all the mean scores found in the Betz study. It seems reasonable to conclude, therefore, that not only did the five treatment groups show statistically significant improvement, but that their posttest mean scores can be considered to be similar to (or better than) those of the average college student.

Comparable posttreatment levels of improvement are also an important consideration when examining the improvement on the Math as a Male Domain and Usefulness of Mathematics Scales. While statistically significant improvement is one measure of success, another measure is comparable posttest mean scores. The actual improvement scores of Groups 4 and 6 were not statistically significant although they were in the anticipated direction. On the Math as a Male Domain Scale, however, Group 4's posttest score was actually higher than any of the control group scores. On

the Usefulness of Mathematics Scale, the relatively high pretreatment scores may have even exacerbated the degree of anxiety these subjects experienced because they began seeing math as highly useful and themselves as unable to perform. Posttest improvement levels for both Groups 4 and 6 on this scale were again not only equal to but higher than posttest scores of all of the control groups.

As mentioned in the previous chapter, no component of the intervention strategy was aimed at changing attitudes toward teachers. Additionally, questions from the scale such as "Math teachers never really paid much attention to me," "My teachers felt that advanced math was a waste of time for me," and "Most of my math teachers probably felt that I was kind of 'dumb' in math" appear to suggest that subjects think of teachers from the past rather than in the present. Such wording is not conducive to pre- to posttest change. No differences, therefore, were expected or found on the Perception of Attitudes of Teachers Scale. This scale was included in the study for its usefulness as a diagnostic tool in the initial interview.

Of interest, however, were the significant differences between males and females which were found on the Teacher Scale as well as on Math Anxiety and Confidence Scales. Males were found to have a significantly more positive perception of teachers' attitudes toward them as learners of mathematics. Part of the reason for this difference may stem from teachers themselves believing math to be a male

domain. Ernest (1976) reported that 41 percent of the elementary and high school teachers in one study believed boys to be better at mathematics than girls while not one thought that girls were better. Ernest suggested that this expectation that males do better in mathematics might well serve as a self-fulfilling prophesy in education generally. Solano (1977) found that teachers have more negative perceptions of mathematically gifted girls than they do of mathematically gifted boys. Girls gifted in math, therefore, may not receive notice or encouragement and thus may lose interest.

The importance of positive perceptions of attitudes of teachers has been shown in another study (Probert, Note 2) in which the strongest correlations found were between higher scores on the Teacher Scale and lower levels of math anxiety, higher levels of confidence, effectance motivation, higher SAT-Math scores, more adequate math backgrounds, and higher final grades in a math course. No other relationships were found between attitudes of significant others (mothers, fathers, counselors or peers) and SAT-Math scores or final grades.

Main effect significant male-female differences were also found on the Math Anxiety and Confidence Scales. These results concur with Fennema and Sherman's (1977) findings that high school girls were not as confident in their ability to perform in mathematics as boys were, with Betz's (1978) findings that college females reported significantly

higher levels of math anxiety than did males in two out of three subject groups, and with Probert's (Note 2) findings that college males reported significantly lower levels of math and test anxiety and higher levels of confidence than did females. The sex-related differences in test anxiety, however, were not confirmed in the present study.

In the Fennema-Sherman study (1977) boys were significantly more confident than girls in their abilities to deal with mathematics at every grade from 6-12. This difference occurred in most instances when no significant sex-related differences in mathematics achievement were found. Moreover, confidence in learning mathematics was found to be more highly related to achievement (r = .40) than any other affective variable on the Fennema-Sherman Attitude Scales. Confidence in learning math has been strongly related also to intent to take advanced high school mathematics courses (Sherman & Fennema, 1977).

Ernest (1976) reported that boys, girls and teachers all believe that boys are superior in mathematics at least by the time students get to adolescence, despite evidence to the contrary. These sex-related differences on the Math Anxiety, Confidence in Learning Mathematics and Teacher Scales need to be investigated further. When do sex-related differences in confidence develop and what contributes to their development? What strategies could be planned to intervene and at what age should they be implemented?

The Spielberger A-Trait and Test Anxiety Scales offer interesting results. It appears that the subjects in all treatment and control groups may be considered to be one population in regard to A-Trait anxiety. There were no significant differences in this relatively stable measure of anxiety among all subjects in the pretest sample, among all subjects in the posttest sample, or between pre- and posttreatment measures for any group when compared to other groups. One interpretation of this finding is that math anxiety appears to be found among students who are not unusually anxiety prone in general. The very low, non-significant relationship (r = -.15) found between math anxiety and trait anxiety in treatment subjects would tend to confirm this conclusion. The higher correlation between math anxiety and trait anxiety (r = -.52) found in control subjects, however, is not readily explainable and should be subjected to further analyses. Betz (1978) reported a relatively low (r = -.28) statistically significant relationship between the two measures of anxiety. One possible hypothesis is that as the mean level of math anxiety increases in a group, the relationship between math anxiety and trait anxiety decreases.

There was a strong, statistically significant pretest relationship found (r = -.51, $p < .001$) between math anxiety and test anxiety in treatment subjects. The posttest correlation was r = -.43, $p < .001$. While only a very small component of the Math Confidence Workshops addressed test

anxiety and test-taking skills, it appears that the treatment brought about not only a reduction in math anxiety but also in test anxiety. Statistically significant pre- to posttreatment improvement differences when compared with controls were found for all treatment groups (again, with the exception of Group 5). Inasmuch as much of the treatment strategy was aimed at cognitive restructuring, it was encouraging to find that all six treatment groups improved significantly posttest on the Worry component of Test Anxiety. Emotionality component mean scores also improved significantly (with the exception of Group 5).

These data are strengthened by the findings from the Follow-up Questionnaire. On a seven-point scale from (1) no anxiety to (7) very high anxiety, subjects' perception of their level of test anxiety went from 5.6 before the group to 3.2 after the group to 3.2 presently. It was encouraging to find this self-perception of long-lasting change.

Perhaps the greatest strength of the entire study is found in the results of the Follow-up Questionnaire. The extremely unusually high return rate of 84 percent makes a statement of how important the Math Confidence groups were to the subjects. Strong positive results regarding the extent to which they felt their educational, career, and other life decisions were positively influenced by the Math Group and the extent to which the Math Group was important compared to other academic activities at the University

confirm this conclusion. Follow-up study results confirm the findings on the measures used in this study and also confirm the predictions for long-lasting improvements.

Implications of the Results

This study was successful inasmuch as it proved to present a much needed efficacious group treatment strategy for the reduction of math anxiety and the raising of levels of confidence in the use and performance of mathematics. The original treatment study measured short-term results which were predicted to be long lasting. The follow-up study found that there were continued positive improvements in such areas as math performance, ability to learn and use mathematics, and other behavioral dimensions addressed in the groups, and also in the reduction of math anxiety and test anxiety. There was also felt to be a greater than average extent to which performance in other courses and in everyday life had been improved. Finally, and perhaps even more importantly, there appeared to be a long-lasting positive self-concept change in subjects' perception of themselves as learners of mathematics.

Math anxiety has been shown to be a widespread phenomenon on college campuses which seriously interferes with learning and academic and career goals. The results of this study should be generalizable to a wide range of college students, with ages from 18 to 55 and GPA's from 2.0 to 4.0.

Richardson and Woolfolk (1980) have recommended that research emphasize the evaluation of ongoing projects in natural settings rather than artificial one-treatment studies which seldom include long-term effects. This study does, in fact, investigate the longer-term durability of effects of such treatment intervention.

Another benefit of the study has been the relationship which is beginning to develop and strengthen between mathematicians and the Math Anxiety Clinic at the University Counseling Center as the result of positive feedback from students in the study. This growing collaboration can only be a benefit to students suffering from psychological blocks in mathematics.

A possible criticism of the study is one of construct validity. Tryon (1980) after urging researchers to discontinue unidimensional treatment and to develop complex, multimodal package treatments suggests the following:

> Complex treatment packages present construct validity problems for the researcher in that the packages may so hopelessly confound procedures that it is impossible to tell for certain which components of the packages are more or less effective. But, as indicated earlier, the sacrifice of construct validity is often one of the trade-offs made by applied researchers. (p. 366)

Future Directions for Research

Systematic evaluations of controlled treatment programs for math anxiety are still in short supply, and long-term

follow-up studies have been nonexistent in the literature. Continued research is also needed on the nature of math anxiety, especially research which will then be able to focus on prevention. Collaborative efforts between psychologists and mathematicians may well prove to be beneficial in this area.

There is a very great need for improved instruments to measure math anxiety. Tryon (1980) has been severely critical of the only other commonly used instrument, the Mathematics Anxiety Rating Scale (MARS), inasmuch as it is a measure of emotionality alone. New instruments should have items addressing the worry component as well which appears to be as much a functional part of math anxiety as it does of test anxiety. Treatments using these newly developed instruments could then test the latter hypothesis. Other research providing a stronger theoretical basis for math anxiety should be in great demand.

Needed too are research strategies aimed at preventing math anxiety and lack of confidence among younger students and especially among girls. Mathematics learning could thereby be improved, more students would elect to take advanced courses in mathematics, and there would be less need for intervention strategies at the university level. As a part of this prevention program it seems important also that elementary and secondary teachers who teach mathematics be made aware of the findings of this relatively new area of math anxiety research, of their own attitudes toward

mathematics, and of their impact on students as well as the consequences of that influence.

Individual differences between various "forms" of math anxiety could also be explored to assist in assessment and treatment. Sorely needed too are well designed studies which further investigate the relationship between math anxiety and performance measures. As has been learned from the test anxiety literature, researchers need to have an awareness of the complex, multidimensional nature of math anxiety and must develop multifaceted approaches which have more prospect of making lasting, significant changes.

APPENDIX A
FENNEMA-SHERMAN MATHEMATICS ATTITUDES SCALES

Appendix A-1

Mathematics Anxiety Scale

1. + It wouldn't bother me at all to take more math courses.

2. + I have usually been at ease during math tests.

3. + I have usually been at ease in math classes.

4. + I usually don't worry about my ability to solve math problems.*

5. + I almost never get uptight while taking math tests.*

6. - I get really uptight during math tests.*

7. - I get a sinking feeling when I think of trying hard math problems.

8. - My mind goes blank and I am unable to think clearly when working mathematics.

9. - Mathematics makes me feel uncomfortable and nervous.

10. - Mathematics makes me feel uneasy and confused.

---

*Indicate items revised from those on the original Fennema-Sherman Scales.

Appendix A-2

Confidence in Learning Mathematics Scale

1.	+	Generally I have felt secure about attempting mathematics.
2.	+	I am sure I could do advanced work in mathematics.
3.	+	I have a lot of self-confidence when it comes to math.
4.	+	I think I could handle more difficult mathematics.
5.	+	I have the ability to get good grades in math courses.
6.	-	I'm no good in math.
7.	-	I'm not the type to do well in math.
8.	-	Most subjects I can handle all right, but I have a knack for flubbing up math.
9.	-	Math has been my worst subject.
10.	-	Even though I study, math seems unusually hard for me.

Appendix A-3

Math as a Male Domain Scale

1. \+ Men and women are equally good in math.*
2. \- Planning a career in mathematics is more appropriate for men than for women.*
3. \- Men are more interested in math than are women.*
4. \- I would expect a woman mathematician to be a masculine type of person.
5. \- Males have more ability to do math than do females.*
6. \- Most men are logical and do well in mathematics.*
7. \- Learning math is harder for women than for men.*
8. \- It's hard to believe that a female could be a genius in mathematics.
9. \- I would rather study math with a man than with a woman.*

---

*Indicate items revised from those on the original Fennema-Sherman Scales.

Appendix A-4

Usefulness of Mathematics Scale

1. + I'll need mathematics for my future work.
2. + Mathematics is a worthwhile and necessary subject.
3. + In my adult life, I will use mathematics in many ways.
4. + I study mathematics because I know how useful it is.
5. - Mathematics is of no relevance to my life.
6. - I only take math courses because they are required.*
7. - Mathematics will not be important to me in my life's work.
8. - Taking mathematics is a waste of time.
9. - I expect to have little use for mathematics when I get out of school.
10. - In terms of my adult life, it's not important for me to do well in mathematics.

---

*Indicate items revised from those on the original Fennema-Sherman Scales.

Appendix A-5

Effectance Motivation in Mathematics Scale

1. + Mathematics is enjoyable and stimulating to me.
2. + Once I start trying to work on a math puzzle, I find it hard to stop.
3. + When a question is left unanswered in math class, I continue to think about it afterwards.
4. + I am challenged by math problems I can't understand immediately.
5. + When I get to a math problem that I can't solve immediately, I stick with it until I have the solution.
6. - The challenge of math problems does not appeal to me.
7. - I do as little work in math as possible.
8. - I don't understand how some people can spend so much time on math and seem to enjoy it.
9. - I would rather have someone give me the solution to a difficult math problem than to have to work it out for myself.
10. - Figuring out mathematical problems does not appeal to me.

Appendix A-6

Teacher Scale

1. + My teachers encouraged me to study more mathematics.
2. + Math teachers have made me feel I have the ability to go on in mathematics.
3. + My math teachers encouraged me to take all the math I could.
4. + My math teachers have been interested in my progress in mathematics.
5. + I have talked with my math teachers about a career which uses math.
6. - My teachers felt that advanced math was a waste of time for me.
7. - Getting a mathematics teacher to take me seriously has usually been a problem.
8. - My teachers wouldn't think I was serious if I told them I was interested in a career in science and mathematics.
9. - Math teachers never really paid much attention to me.*
10. - Most of my math teachers probably felt that I was kind of "dumb" in math.*

---

*Indicate items revised from those on the original Fennema-Sherman Scales.

APPENDIX B
SPIELBERGER TEST AND TRAIT ANXIETY INVENTORIES

Appendix B-1

Test Anxiety Inventory (TAI)

1. - I feel confident and relaxed while taking tests.
2. + While taking final examinations I have an uneasy, upset feeling.
3. + Thinking about the grade I may get in a course interferes with my work on tests.
4. + I freeze up on final exams.
5. + During exams I find myself thinking about whether I'll ever get through college.
6. + The harder I work at taking a test, the more confused I get.
7. + Thoughts of doing poorly interfere with my concentration on tests.
8. + I feel very jittery when taking an important test.
9. + Even when I'm well prepared for a test, I feel very anxious about it.
10. + I start feeling very uneasy just before getting a test paper back.
11. + During tests I feel very tense.
12. + I wish examinations did not bother me so much.
13. + During important tests I am so tense that my stomach gets upset.
14. + I seem to defeat myself while working on important tests.
15. + I feel very panicky when I take an important test.
16. + If I were to take an important examination, I would worry a great deal before taking it.
17. + During tests I find myself thinking about the consequences of failing.
18. + I feel my heart beating very fast during important tests.

19. + As soon as an exam is over I try to stop worrying about it, but I just can't.

20. + During a course examination I get so nervous that I forget facts I really know.

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Appendix B-2

STAI A-Trait Scale

1.	-	I feel pleasant.
2.	+	I tire quickly.
3.	+	I feel like crying.
4.	+	I wish I could be as happy as others seem to be.
5.	+	I am losing out on things because I can't make up my mind soon enough.
6.	-	I feel rested.
7.	-	I am "cool, calm, and collected."
8.	+	I feel that difficulties are piling up so that I cannot overcome them.
9.	+	I worry too much over something that really doesn't matter.
10.	-	I am happy.
11.	+	I am inclined to take things hard.
12.	+	I lack self-confidence.
13.	-	I feel secure.
14.	+	I try to avoid facing a crisis or difficulty.
15.	+	I feel blue.
16.	-	I am content.
17.	+	Some unimportant thought runs through my mind and bothers me.
18.	+	I take disappointments so keenly that I can't put them out of my mind.
19.	-	I am a steady person.
20.	+	I get in a state of tension or turmoil as I think over my recent concerns and interests.

APPENDIX C
MATHEMATICS BACKGROUND FORM

MATHEMATICS BACKGROUND FORM

Date_____

Name_____Address_____ Phone_____

Major_____Year in school (Classification)_____

G.P.A._____

Sex_____ (1) Female--(2) Male

Age_____

*1. Have you participated in other math anxiety/avoidance programs? (1) Yes, (2) No. If yes, please indicate _____

*2. How did you find out about this Math Anxiety/Avoidance Program?_____

*3. Please describe as completely as possible why you are enrolling in the Math Confidence Program and then list three specific goals which you hope to achieve by the end of the program._____
_____
_____

Specific Goals: a. _____
b. _____
c. _____

*4. How many semesters of math did you take while you were in high school (i.e., gr. 9 through 12)? (If none, indicate 0. _____

*5. Which of the following math courses did you have while you were in high school. Please check all which apply.

____ General math
____ Business math
____ First year algebra
____ Geometry
____ Second year algebra
____ Trigonometry
____ Solid geometry
____ Calculus

*6. What was the typical grade you achieved in high school math classes? _____

*7. Have you completed any math courses since you graduated from high school? Check one ____(1) Yes ____(2) No. If yes, please list. _____
What grade did you receive?____Have you ever dropped a math course?___(1) Yes ___(2)___No. If yes, please list._____

*8. How many years have lapsed since your last formal math instruction?_____

*9. Which one of the following math classes do you think would be the most appropriate if you were to begin taking math again?

___(1) Arithmetic and Elementary Algebra
___(2) Mathematics: Intermediate Algebra
___(3) College Algebra and Analytic Geometry
___(4) Other _____
___(5) Taking math course now.
Name of course_____
So far my grades in the course have been_____

*10. How do you consider your math ability to be? (Check one)

___(1) Terrible
___(2) Very poor
___(3) Poor
___(4) Average
___(5) Good
___(6) Very good
___(7) Excellent

*11. Please indicate your attitudes concerning mathematics (e.g., studying it, doing problems, what math is) by circling your response for each of the following.

	Not True At All	Slightly True	Somewhat True	Very True	Extremely True
I look forward to it.	1	2	3	4	5
I consider it an opportunity to learn.	1	2	3	4	5
I consider it an obligation I must fulfill	1	2	3	4	5
I consider it an unpleasant task.	1	2	3	4	5
I consider it an opportunity to be creative.	1	2	3	4	5
I dislike it intensely.	1	2	3	4	5
I avoid it whenever I can.	1	2	3	4	5
I regard it as a mystery.	1	2	3	4	5

*12. Who helped you with your homework in each of the following areas?

	Mother	Father	Both Equally	Another Family Member	Nobody Helped Me	Cannot Remember
Math	1	2	3	4	5	6
English	1	2	3	4	5	6
Science	1	2	3	4	5	6
Social Studies	1	2	3	4	5	6

*13. Please describe as fully as possible your mother's attitude toward math and her ability to do math. _____

*14. Please describe as fully as possible your father's attitude toward math and his ability to do math. _____

*15. Who is better at math: boys, girls, or both are equal? ___(1) Boys ___(2) Girls ___(3) Both are the same. Please discuss your answer. _____

*16. Please describe your experiences, and how you felt, with math in grade school. What was your math instruction like and how well did you do? _____

*17. Please describe your experiences, and how you felt, with math in high school. What was your math instruction like? _____

*18. How have your feelings about your ability in math affected you? What, if anything, have you been prevented from doing? _____

*19. What math do you use most in your daily life? _____

*20. What math, if any, do you typically use in your present work (if any)? _____
_____
_____

*21. What areas of math, if any, are particular problem areas for you? _____
_____
_____

22. When did you first have difficulty understanding math (arithmetic)?

What were you learning? (fractions, word problems, algebra, geometry, calculus)

What was it like?

What was the teacher like?

The reason(s) I'm having difficulty with math now is (are)

23. How do you feel when you go into your math (statistics, physics, etc.) class? (Or imagine you would feel--if you are not taking a class now)

24. How do you feel when you open your math (statistics, etc.) book to study?

25. What are your expectations

--in the class?

--when you do your homework?

--in exams?

--as to what grade you will receive?

26. How good is your intuition in math?

27. Is there such a thing as a "mathematical mind"?
(1)___Yes (2)___No

If yes, do you have one?
(1)___Yes (2)___No

28. Do you believe that some people are good at math and others are good at language (verbal skills)?
(1)___Yes (2)___No

If yes, which are you good at?
(1)___Math (2)___Verbal Skills

29. Do you believe that there is a "ceiling" to mathematical ability?
(1)___Yes (2)___No.

30. Please describe some positive experiences you have had in math. _____
_____
_____

---

*Items with an * are from Sandra Davis's Math Anxiety Program Diagnostic Clinic, University of Minnesota.

APPENDIX D
CONTROL GROUP GENERAL INFORMATION FORM

CONTROL GROUP GENERAL INFORMATION FORM

General Information Part I

1. Participant Identification Number _____

2. Year in school (Classification) _____

3. Name of math or statistics course (if any) presently taking _____

4. Sex (1) Male_____ (2) Female_____

5. Race: (1) Caucasian_____ (2) Black_____
(3) Spanish _____ (4) Other_____

6. Age _____

7. GPA _____

8. How do you consider your math ability to be? (Check one)

(1) Terrible____ (2) Very poor____ (3) Poor____
(4) Average ____ (5) Good _____ (6) Very good ____
(7) Excellent____

9. Is there such a thing as a "mathematical mind"?
(1) Yes___ (2) No___

If yes, do you have one?
(1) Yes___ (2) No___

10. I would be interested in a Math Confidence Workshop in the future.
(1) Yes___ (2) No___

APPENDIX E
MATH CONFIDENCE WORKSHOP OUTLINES

APPENDIX E-1

MATH CONFIDENCE WORKSHOP SESSION I

I. Confidentiality Policy

II. Introductions and Overview of Session

III. Math Anxiety--Short History

Rationale of Workshop

IV. Film: Math Anxiety: We Beat It, So Can You!

V. Discussion:

Why I've come to the group.
What I expect to get from the group.
What my past experiences with math have been.
How I feel about doing math.
How my family and friends feel about my doing math.
Etc.

VI. Concepts:

A. Cycle of Failure
B. Laws of Suggestion: The Law of Concentrated Attention
The Law of Reversed Effect

VII. Contracts

VIII. Assignments based on the above principles:

A. Get a looseleaf notebook. Keep all materials in it and bring it with you every week.

B. Make out a daily schedule. Plan the most important things (math, statistics, homework) first. Be prepared to revise as you go along. Make a weekly schedule. Be aware of your feelings and self-talk as you make your schedules.

C. Get a calendar book. Mark down all scheduled exams so that you can plan ahead.

D. Graph your time spent studying math, statistics, etc. Be prepared to share it with the group next week.

E. Start you math journal. Record date and time, situation and setting, thoughts, self-talk,

feelings, tension level (0-100), and consequences. Be especially aware of negative thoughts and self-statements regarding math.

IX. Talks by students from previous Math Confidence Groups. Discussion. (Visualize yourself talking to the next term's group.)

APPENDIX E-2

CONTRACT: MATH WORKSHOP

I realize that doing well in math (statistics, etc.) is going to require hard work. I therefore agree to the following:

I will attend every math (statistics, etc.) class.

I will try to sit in the front of the class.

If I have to miss a class (in the case of something super-extraordinary), I will contact the professor, classmates, etc. and go back to make sure that I have learned all the material I missed.

I will attend all seven math Confidence group meetings because I realize that commitment to the group is an essential part of my reaching my goals and that absences sabotage the group. (In the case of REALLY unusual circumstances, I will call the group leader BEFORE the group session and will be responsible for makeup). I will study my math, etc., ahead of time so that I will not have to study for exams during group time.

I will ready my math book before the professor discusses the chapter. I will keep up with or a little ahead of the class in math. I will schedule my time so that I am able to do this.

I will have at least two or three math (statistics, etc.) books which I can use for reference or I will know where I can find them easily at the library or elsewhere.

I will not be afraid or embarrassed to seek help when I need it.

I realize that this list does not include all that I need to do to get the grade (understanding, knowledge and expertise) that I want. To the best of my ability I will try to discover anything else that will be helpful, and I will be responsible for making appropriate changes.

I will also try to like and enjoy myself just the way I am.

CONFIDENTIALITY I agree that whatever is discussed in the group by group members is confidential.

Signed:_____

This contract is for your notebook. It is not to be turned in to the group leader.

APPENDIX E-3

MATH CONFIDENCE WORKSHOP SESSION II

I. Review and group discussion (What went well? What need more work on? What did you learn about yourself?)

II. Planning your own individual treatment program: (Self-scientist)

A. Goals:

1. To increase time spent in study--quality.
2. To increase the effectiveness (and enjoyment) of the time spent--quality.
3. To change my self-concept to that of person who is competent in math.
4. To recognize how and when my beliefs and self-statements affect my emotions.
5. To learn to encourage myself for small achievements.
6. To learn how to learn mathematics more effectively.

B. Concepts

1. Functionality of avoidance.
2. Stimulus-response.
3. Self-concept.
   Development of self-image
   Defense mechanisms
   Self-talk
4. Irrational beliefs and building a rational belief system.
   A-B-C sequence

Example

A. Math exam
B. "I'm going to flunk"
C. Panic

A. The stimulus or event.
B. The self-statement and belief about A.
C. The feelings that result from B.

III. How to change: Coping Statements (Cognitive Restructuring).

Exercise

1. Write down A-B-C sequence.
2. Each student with partner.

3. Discuss sequence. Look for generalizations, mistaken beliefs, arbitrary inferences, negative predictions, emotional reasoning, irrational beliefs.
4. Write down a better coping statement for B.

IV. Learning how to learn mathematics more effectively

A. To become an independent learner and problem solver
B. Listening is a mathematical skill. Good listener is an active listener.
C. Awareness, action response, feedback = learning
D. Math questions for good listeners--exercise
E. Listening and visualizing--exercise
F. Where to go for help. Learning Skills Center, Reading & Writing Center, free tutors

V. Assignment

A. Time Schedule Goal

1. Decide on a specified unit of time (15-20 minutes).
2. Decide how many units you will need to study math each day to get B or better.
3. Schedule your plan.
4. Record time on your graph.

B. Continue to write in your journal.
C. Write four ABC sequences on 3 x 5 cards. Change B to a coping statement.
D. To hand in:
   (1) This is what I seem to be doing to keep myself from learning and/or enjoying math (avoidance, procrastination, give up too easily, etc.)
   (2) This is what I am doing to help myself cope better.
   (3) So far the grades in my math class have been:
E. Telephone the next person on the class list and respond as their counselor.
Time limit: five minutes.

APPENDIX E-4

MATH CONFIDENCE WORKSHOP SESSION III

I. Review

II. Group Discussion

III. Problem Solving

A. Polya's How To Solve It Formula for Problem Solving

1. Used two ways:
   1) To solve math problems
   2) To solve math anxiety "problem"--Individual Treatment Plan
2. Four steps:
   1) Understand the problem
   2) Devise a plan
   3) Carry out the plan
   4) Examine the solution, reassess

B. Problem Solving Exercises--Developing strategies, getting comfortable making mistakes, turning off self-evaluative statements, encouraging self with positive coping statement.

1. What is the question? (Understand the problem)
2. Organize the information (Devise a plan)
   a. Make a table or chart
   b. Draw a diagram
3. What are my thoughts and feelings as I work on problems?

IV. Math Beliefs and Strategies

A. Beliefs about Math--Math Myths
Non-conscious ideology: A set of beliefs and attitudes which an individual accepts implicitly but which remain outside his/her awareness because alternative conceptions of the world remain unimagined.

B. Ways We Sabotage Ourselves

C. Don't Let These Statements Get to You

V. Your Individual Treatment Plan--Data Collecting and Intervention, Assignment

A. Time Schedules

1. Continue to schedule manageable units of math study time.
2. Graph time spent studying.
3. Plan a reward (and/or punishment) for yourself for completing the units as planned instead of avoidance behaviors or procrastination. Be specific. (Rewards generally work better than punishments.)
4. Written assignment: Time Schedule Goal
   1) Describe your existing style as an efficiency expert would describe it.
   2) What is your time schedule goal?
   3) How well have you been able to accomplish your goal so far?
   4) How do you feel about your time management, procrastination, avoidance, etc.?

B. Self-Concept (Changing how I talk about myself)

1. Continue to monitor your self-talk. Change negatives to positive coping statements. Change from self-evaluation to self-encouragement.
2. Written assignment:
   1) What have you learned about yourself from writing in your journal?
   2) What are the secondary gains of NOT learning math? (What would you have to GIVE UP if you learn math, really become proficient at it?

C. Contact with Other Group Members
Call the person whose name is on the class list just <u>above</u> yours. See How helpful you can be in <u>listening</u> to how well they are doing and in responding as their "counselor." (five minute time limit) Try to telephone them twice during the week.

APPENDIX E-5

MATH CONFIDENCE WORKSHOP SESSION IV

I. Review and Group Discussion

II. Stress and Relaxation--Discussion

A. Stress or Distress
B. Body Reactions to Stress
C. Components of Stress
D. Type A Personality
E. Common Misconceptions About Stress
F. Stress Management Techniques and Principles
G. Exercise: Relaxation, a coping technique to manage anxiety

III. Yerkes-Dodson Law--For easy tasks, performance increases in arousal; for more difficult tasks (math), performance peaks at intermediate levels. Facilitating and debilitating anxiety. Use anxiety as a cue to relax.

IV. Word Problems

A. How to Read Word Problems
B. Exercise in Word Problem Solving

V. Processing--Group Discussion

A. Tuning in to Our Own Process
B. Giving and Receiving Help

VI. Success and Failure

VII. Assignment--Your Individual Treatment Plan

A. Practice Relaxation. Use anxiety as a cue to relax. Relaxation is a skill which can be learned with practice. Write a sentence or two on your relaxation response.
B. What would you be doing now if it were really impossible for you to fail at mathematics?
C. How might you be inviting frustration?
D. How might you be resisting learning math?
E. Write a precise statement of what you believe your problem is.
F. What defense mechanisms might you be using in order to avoid success?
G. Write a short summary of how you are doing in your math course. Include grades, problems, attendance. How can we help you with the course?

H. Telephone the person whose name is on the class list two positions below yours.
I. Teach someone the word problem from today's exercise. Be aware of your feelings as you teach them.

APPENDIX E-6

MATH CONFIDENCE WORKSHOP SESSION V

I. Review and Group Discussion

II. Exercise--Picture a Mathematician

A. Group Discussions of Individual Imagery
B. Stereotypes and Implicit Personality Theories
   1. Stereotypes of mathematicians
   2. How beliefs affect perceptions
   3. Feelings (anger, resentment, boredom, etc.)

III. Learning Math

A. How I Study Mathematics Exercise (Handout)
B. Concentration
C. Reading Textbooks (SQ3R) and Taking Notes
D. Managing Your Study Time and Time Management Principles
   Lakein's How To Get Control of Your Time and Your Life
   1. Lakein's ABC's
   2. 8/20 rule
   3. Lakein's Question
E. Time Wasters Exercise
F. Examinations
   1. Reviewing
   2. Examination skills
   3. Woolfolk and Richardson's "Anxious Functioning"
      a) Anxious self-talk
      b) Direction of attention
      c) Response to bodily signs of tension
      d) Basic beliefs and assumptions
   4. Examples of Coping Self-statements

IV. Assignment--Individual Treatment Plan

A. Identify areas in which you are not studying effectively. Be as specific as possible.
B. List at least three ways in which you would like to change your study habits.
C. How might you sabotage yourself? And, how could you avoid sabotaging yourself?
D. Discuss "anxious functioning" as it relates to you. What can you learn from this?
E. How might you improve your test-taking strategies?
F. Continue your relaxation, graphs, journal, and your A-B-C sequences. Change B's to effective coping statements.
G. Telephone the person whose name is on the class list two positions above yours.

APPENDIX E-7

MATH CONFIDENCE WORKSHOP

SESSION VI

I. Review and Group Discussion

II. Assertion Training

A. Assertiveness Questionnaire
B. Developing a Belief System
C. Nonassertion, Aggression, and Assertion
D. Roleplay Exercises--Group Members

III. Sex-Role Conflicts

A. Androgyny Scale
B. Bipolar Masculine-Feminine Scale

IV. Doing Math--Exercises

V. Individual Treatment Plan--Assignment

A. Nonassertion, Aggression, and Assertion--(Communication)

Please complete the following:

1. I have identified the following three areas in which I am <u>not</u> an effective communicator:

2. One of the reasons for my not communicating effectively (either being too nonassertive or too aggressive) is:

3. As a result I end up feeling:

4. These are the areas in which I believe I <u>am</u> an effective communicator:

5. Anger and Resentment
   a) I realize I get angry (about, when, at):
   b) I get myself angrier by telling myself that:
   c) One way I can help myself not to get so angry is to:

B. What is the <u>MOST</u> helpful assignment you can give yourself this week in regard to:
1. being more assertive, less nonassertive, less aggressive and/or angry?
2. being more in control of your time?
3. preparing for exams in math?

C. Teach someone the work problem from today's session. Try to make it a positive experience for yourself. Refrain from negative comparisons, self-evaluations and self-judgments. Encourage the other person if appropriate. How did it go?

D. Continue your relaxation, journals, graphs, and A-B-C sequences with B changed to effective coping statements.

E. Telephone the person whose name is on the class list three positions below yours.

F. Think of a math problem that you would like to teach to the group next time.

APPENDIX E-8

MATH CONFIDENCE WORKSHOP SESSION VII

I. Review and Group Discussion

II. Doing Math--Group Members Teaching the Problems

III. Final Discussion

A. What has helped me the most
B. Future goal setting

IV. Posttests and Evaluations

APPENDIX F
FOLLOW-UP QUESTIONNAIRE

FOLLOW-UP QUESTIONNAIRE

PART I

1. To what extent do you feel that your educational, career, or other life decisions were positively influenced by the math group?

   very small extent 1 2 3 4 5 6 7 very large extent
   (Please circle one.)
   OPTIONAL: Please explain (use back if necessary).

2. After participating in the math group, to what extent to you feel your life decisions have been/will be negatively influenced by math anxiety/avoidance?

   very small extent 1 2 3 4 5 6 7 very large extent

3. In your estimation, how important is it that this program be continued at the University of Florida?

   not at all important 1 2 3 4 5 6 7 extremely important

4. Compared to other activities that you participated in at the University (classes, workshops, other academic activities), how important would you rate the math group?

   bottom 20% 1 2 3 4 5 top 20%

5. To what extent did the math group improve your academic performance

   a. in math (or math-related courses)? (If no courses, check does not apply)

      very small extent 1 2 3 4 5 6 7 very large extent
      (D.N.A.___)

   b. in other courses

      very small extent 1 2 3 4 5 6 7 very large extent

   c. in everyday life?

      very small extent 1 2 3 4 5 6 7 very large extent

6. How would you rate your level of anxiety in regard to math (statistics, etc.)?

a. before the group and the initial interview?

no anxiety 1 2 3 4 5 6 7 very high

b. after the group?

no anxiety 1 2 3 4 5 6 7 very high

c. presently?

no anxiety 1 2 3 4 5 6 7 very high

7. How would you rate your level of ability to learn and use math?

a. before the group and the initial interview?

very low (terrible) 1 2 3 4 5 6 7 very high (excellent) 4 = average

b. after the group?

very low (terrible) 1 2 3 4 5 6 7 very high (excellent) 4 = average

c. presently?

very low (terrible) 1 2 3 4 5 6 7 very high (excellent) 4 = average

8. How would you rate your level of <u>test</u> anxiety?

a. before the group and the initial interview?

no anxiety 1 2 3 4 5 6 7 very high

b. after the group?

no anxiety 1 2 3 4 5 6 7 very high

c. presently?

no anxiety 1 2 3 4 5 6 7 very high

9. To what extent do you feel that you have made some <u>positive</u> change, improvement, etc. in the following areas:

a. <u>Self-talk</u> (Less negative self-talk/more positive self-talk)

very small extent 1 2 3 4 5 6 7 very large extent

b. Assertiveness (Less nonassertive/more assertive)

very small extent 1 2 3 4 5 6 7 very large extent

(Less aggressive/more assertive)

very small extent 1 2 3 4 5 6 7 very large extent

c. Less avoidance of math

very small extent 1 2 3 4 5 6 7 very large extent

d. Better study habits

very small extent 1 2 3 4 5 6 7 very large extent

e. Better at time management (less procrastination, etc.)

very small extent 1 2 3 4 5 6 7 very large extent

f. Less stereotyping of mathematicians and those who do well in math

very small extent 1 2 3 4 5 6 7 very large extent

g. Better self-image

very small extent 1 2 3 4 5 6 7 very large extent

h. Using anxiety as a cue to relax

very small extent 1 2 3 4 5 6 7 very large extent

PART II

1. Name_____2. Year in school & major_____

3. Date of (or expected) graduation _____

4. GPA___(Presently or at graduation)

5. Present occupation (if other than student)_____

PART III

Comments (OPTIONAL).

APPENDIX G
INFORMED CONSENT FORMS

UNIVERSITY OF FLORIDA
DEPARTMENT OF PSYCHOLOGY CONSENT FORM

Subject's name_____

Subject's address_____

Project Number____ Project Title Investigating Attitudes Toward Mathematics

Principal Investigator Barbara S. Probert Date_____

I agree to participate in the research as explained to me below:

This research was designed to investigate how attitudes and other factors relate to performance in mathematics. The questionnaires I will be filling out now and again later in the term will ask my opinions about a variety of attitudes toward mathematics, test taking, and related issues.

I realize that my name will be used on the questionnaire only in an organizational manner, my name will not be attached to any of the information that I provide, and my mathematics instructor will not see any of the completed questionnaires.

The above stated nature and purpose of this research has been explained to me verbally by Barbara Probert or Paul G. Schauble. Furthermore, it is agreed that the information gained from this investigation may be used for educational purposes which may include publication. I understand that I may withdraw my consent at any time without prejudice.

Signed_____

I have defined and fully explained this research to the participant whose signature appears above.

Signed_____
Barbara S. Probert
Principal Investigator

INFORMED CONSENT FORM

This research was designed to investigate how attitudes toward mathematics covary with attitudes about school in general, test-taking, and related issues and how these attitudes may change. The questionnaire you will be filling out now and later in the term will ask your opinions about mathematics as well as your feelings about studying this subject. In addition, you will be asked to estimate what the opinions of the teachers are on these same subjects. You will also be asked your opinion of the importance of mathematics both in school and in "real life." Finally, your opinions about yourself and related issues will be assessed.

Your participation will be held in strict confidence and your name will not appear on any forms except this one, giving us your informed consent to participate in this study. If you agree to participate, please sign and date this form, tear it off from the rest of the questionnaires and turn it in separately. That way you won't be identified with your responses on the questionnaires. You may keep one copy of the consent form for your own records.

Please DO NOT write your name anywhere on the questionnaires. You will be asked to indicate your year in school, whether or not you are taking a course in mathematics and/or statistics, your sex, race, age, and GPA and some related questions.

PLEASE WRITE THE NUMBER APPEARING ON YOUR PARTICIPANT IDENTIFICATION CARD ON YOUR QUESTIONNAIRE. PLEASE RETURN THE CARD TO US SO THAT YOU WILL BE ABLE TO PUT THE SAME NUMBER ON THE QUESTIONNAIRE YOU FILL OUT LATER IN THE TERM. NO CREDIT CAN BE GIVEN UNLESS YOU FILL OUT BOTH FORMS USING THE SAME NUMBER. To protect your anonymity, the identification cards will be destroyed before the questionnaires are analyzed.

There is no monetary compensation for this experiment, and you may feel free to withdraw your consent and to discontinue participation at any time. There are no other benefits or risks that you should expect. Your anonymity will be safeguarded at all times.

If you have any questions, please feel free to ask the experimenter from whom you received the questionnaire.

I have read and I understand the procedure described above. I agree to participate in the procedure and I have received a copy of this description.

SIGNATURES:

_____	_____	_____	_____
Subject	Date	Witness	Date
_____	_____	_____	_____
Relationship if other than subject	Date	Principal Investigator Barbara S. Probert	Date

APPENDIX H
DUNCAN'S MULTIPLE RANGE TESTS FOR TREATMENT AND CONTROL GROUPS

Appendix H-1

Duncan's Multiple Range Test
Math Anxiety Scale

Group	n	Pretreatment					Posttreatment				
		M	A	B	C	D	M	A	B	C	D
Treatment											
1	8	16.88				X	33.75	X			
2	8	18.38			X	X	32.63	X			
3	11	18.73			X	X	29.45	X	X	X	
4	9	18.89			X	X	34.45	X			
5	5	16.40				X	22.40			X	
6	9	14.11				X	27.89	X	X	X	
Control											
Psychology 1	34	36.18	X				36.24	X			
Psychology 2	12	25.17		X	X		23.42		X	X	
Math Classes	20	30.25	X	X			30.90	X	X		

Note. Means with the same letter are not significantly different at .05.

Appendix H-2

Duncan's Multiple Range Test
Confidence in Mathematics Scale

		Pretreatment					Posttreatment				
Group	n	M	A	B	C	D	M	A	B	C	D
Treatment											
1	8	22.88			X		34.50	X	X		
2	8	24.13			X		34.75	X	X		
3	11	23.73			X		34.10	X	X		
4	9	23.67			X		37.33	X	X		
5	5	21.40			X		29.20		X	X	
6	9	18.67			X		29.78		X	X	
Control											
Psychology 1	34	38.74	X				38.94	X			
Psychology 2	12	25.92		X	X		24.83			X	
Math Classes	20	32.75	X	X			32.25	X	X	X	

Note. Means with the same letter are not significantly different at .05.

Appendix H-3

Duncan's Multiple Range Test
Male Domain Scale

Group	n	Pretreatment M	A	B	C	D	Posttreatment M	A	B	C	D
Treatment											
1	8	35.75	X	X	X		39.25	X	X		
2	8	30.00			X		36.63	X	X		
3	11	35.27	X	X	X		40.00	X			
4	9	33.89	X	X	X		39.33	X	X		
5	5	31.40		X	X		33.60		X		
6	9	29.22			X		35.33	X	X		
Control											
Psychology 1	34	37.27	X	X			36.50	X	X		
Psychology 2	12	38.50	X				37.00	X	X		
Math Classes	20	36.85	X	X			36.60	X	X		

Note. Means with the same letter are not significantly different at .05.

Appendix H-4

Duncan's Multiple Range Test
Usefulness Scale

		Pretreatment					Posttreatment				
Group	n	M	A	B	C	D	M	A	B	C	D
Treatment											
1	8	34.88	X	X			43.00	X			
2	8	33.88	X	X			39.63	X	X		
3	11	32.45		X			39.36	X	X		
4	9	39.00	X	X			41.78	X	X		
5	5	32.80		X			36.60		X		
6	9	38.11	X	X			40.44	X	X		
Control											
Psychology 1	34	40.15	X				39.68	X	X		
Psychology 2	12	39.17	X	X			38.42	X	X		
Math Classes	20	39.70	X				39.70	X	X		

Note. Means with the same letter are not significantly different at .05.

Appendix H-5

Duncan's Multiple Range Test
Effectance Motivation Scale

		Pretreatment					Posttreatment				
Group	n	M	A	B	C	D	M	A	B	C	D
Treatment											
1	8	19.50		X			30.50	X	X		
2	8	23.38	X	X			31.88	X	X		
3	11	25.00	X	X			31.00	X	X		
4	9	27.67	X	X			35.33	X			
5	5	21.20		X			25.00		X		
6	9	21.78		X			29.11	X	X		
Control											
Psychology 1	34	31.38	X				31.24	X	X		
Psychology 2	12	25.91	X	X			26.00		X		
Math Classes	20	27.00	X	X			27.55	X	X		

Note. Means with the same letter are not significantly different at .05.

Appendix H-6

Duncan's Multiple Range Test
Teachers Scale

Group	n	Pretreatment M	A	B	C	D	Posttreatment M	A	B	C	D
Treatment											
1	8	25.13		X	X	X	25.13		X	X	
2	8	30.25	X	X	X		28.88		X	X	
3	11	24.36			X	X	25.64		X	X	
4	9	28.22		X	X	X	29.00		X	X	
5	5	23.40			X	X	25.20		X	X	
6	9	22.56				X	23.22			X	
Control											
Psychology 1	34	36.41	X				36.38	X			
Psychology 2	12	28.00		X	X	X	28.83		X	X	
Math Classes	20	31.95	X	X			31.15	X	X		

Note. Means with the same letter are not significantly different at .05.

Appendix H-7

Duncan's Multiple Range Test
A-Trait Anxiety Scale

Group	n	Pretreatment M	A	B	C	D	Posttreatment M	A	B	C	D
Treatment											
1	8	42.13	X				37.50	X			
2	8	40.88	X				37.25	X			
3	11	43.73	X				37.35	X			
4	9	44.00	X				37.67	X			
5	5	41.00	X				40.80	X			
6	9	42.56	X				39.22	X			
Control											
Psychology 1	34	36.15	X				36.15	X			
Psychology 2	12	40.92	X				44.25	X			
Math Classes	20	37.70	X				37.55	X			

Note. Means with the same letter are not significantly different at .05.

Appendix H-8

Duncan's Multiple Range Test
Test Anxiety Scale

		Pretreatment					Posttreatment				
Group	n	M	A	B	C	D	M	A	B	C	D
Treatment											
1	8	48.88	X	X			31.63		X		
2	8	46.00	X	X	X		35.75		X		
3	11	51.91	X	X			42.45	X	X		
4	9	54.33	X	X			36.11		X		
5	5	56.60	X				48.60	X			
6	9	53.67	X	X			41.00	X	X		
Control											
Psychology 1	34	35.88			X		33.82		X		
Psychology 2	12	52.50	X	X			50.67	X			
Math Classes	20	42.65		X	X		42.65	X	X		

Note. Means with the same letter are not significantly different at .05.

Appendix H-9

Duncan's Multiple Range Test
Worry Component Test Anxiety

		Pretreatment					Posttreatment				
Group	n	M	A	B	C	D	M	A	B	C	D
Treatment											
1	8	17.37	X	X	X		12.25			X	
2	8	16.87	X	X	X		13.88		X	X	
3	11	19.36	X	X			16.64	X	X	X	
4	9	20.67	X	X			14.22	X	X	X	
5	5	22.40	X				18.00	X	X		
6	9	20.00	X	X			15.11	X	X	X	
Control											
Psychology 1	34	13.47			X		12.74			X	
Psychology 2	12	19.67	X	X			18.66	X			
Math Classes	20	15.85		X	X		15.65	X	X	X	

Note. Means with the same letter are not significantly different at .05.

Appendix H-10

Duncan's Multiple Range Test
Emotionality Component Test Anxiety

		Pretreatment					Posttreatment				
Group	n	M	A	B	C	D	M	A	B	C	D
Treatment											
1	8	20.75	X				13.25			X	
2	8	18.75	X	X			14.88		X	X	
3	11	21.73	X				17.09	X	X	X	
4	9	21.78	X				14.33		X	X	
5	5	22.20	X				20.60	X			
6	9	21.89	X				16.89	X	X	X	
Control											
Psychology 1	34	15.26		X			14.32		X	X	
Psychology 2	12	21.33	X				20.92	X			
Math Classes	20	18.15	X	X			18.20	X	X		

Note. Means with the same letter are not significantly different at .05.

APPENDIX I
ANALYSES OF VARIANCE BY SEX, GROUP AND TIME

Appendix I-1

Analysis of Variance by Sex, Group and Time
Math Anxiety Scale

	df	Mean Square	F
Sex	1	670.06	4.63*
Time	1	2280.94	167.88**
Group x Time	1	2221.69	163.52**
Group x Sex	1	33.95	2.50
Group x Sex x Time	1	6.99	.51

	Control				Treatment			
	Males[a]		Females[b]		Males[c]		Females[d]	
	M	SD	M	SD	M	SD	M	SD
Pretest	34.50	8.78	31.46	10.73	19.27	6.31	16.51	5.92
Posttest	35.05	8.00	31.09	10.87	34.20	7.42	29.00	7.73

Note. Possible scores range from 10 to 50. Lower scores indicate higher levels of math anxiety.

[a] $n = 20$.

[b] $n = 46$.

[c] $n = 15$.

[d] $n = 35$.

*$p < .05$.

**$p < .001$.

Appendix I-2

Analysis of Variance by Sex, Group and Time
Confidence

	df	Mean Square	F
Sex	1	1104.84	7.82*
Time	1	1433.63	113.32**
Group x Time	1	1526.24	120.64**
Group x Sex	1	.81	.06
Group x Sex x Time	1	.09	.01

	Control				Treatment			
	Males[a]		Females[b]		Males[c]		Females[d]	
	M	SD	M	SD	M	SD	M	SD
Pretest	38.15	7.65	33.04	10.60	25.47	7.24	21.23	6.76
Posttest	38.15	7.54	32.70	10.82	36.67	6.98	32.26	7.18

Note. Possible scores range from 10 to 50. Higher scores are indicative of greater confidence in learning mathematics.

[a] $n = 20$.

[b] $n = 46$.

[c] $n = 15$.

[d] $n = 35$.

*$p < .01$.

**$p < .001$.

Appendix I-3

Analysis of Variance by Sex, Group and Time
Math as a Male Domain

	df	Mean Square	F
Sex	1	44.48	.70
Time	1	162.15	15.80*
Group x Time	1	323.48	31.52*
Group x Sex	1	21.70	2.11
Group x Sex x Time	1	19.12	1.86

	Control				Treatment			
	Males[a]		Females[b]		Males[c]		Females[d]	
	M	SD	M	SD	M	SD	M	SD
Pretest	34.35	6.45	38.67	5.52	35.40	6.96	31.66	6.87
Posttest	33.55	5.87	37.96	6.28	38.53	5.51	37.40	5.24

Note. Possible scores range from 9 to 45. Higher scores indicate less tendency to view math as a male domain.

[a] $n = 20$.

[b] $n = 46$.

[c] $n = 15$.

[d] $n = 35$.

*$p < .001$.

Appendix I-4

Analysis of Variance by Sex, Group and Time
Usefulness

	df	Mean Square	F
Sex	1	184.01	2.84
Time	1	353.76	32.86**
Group x Time	1	469.48	43.60**
Group x Sex	1	44.71	4.15*
Group x Sex x Time	1	53.12	4.93*

	Control				Treatment			
	Males[a]		Females[b]		Males[c]		Females[d]	
	M	SD	M	SD	M	SD	M	SD
Pretest	41.65	6.51	39.04	5.68	34.87	9.46	35.49	6.14
Posttest	41.15	6.84	38.71	5.64	42.73	5.16	39.31	5.35

Note. Possible scores range from 10 to 50. Higher scores indicate more positive attitudes toward the usefulness of mathematics.

[a] $n = 20$.

[b] $n = 46$.

[c] $n = 15$.

[d] $n = 35$.

*$p < .05$.

**$p < .001$.

Appendix I-5

Analysis of Variance by Sex, Group and Time
Effectance Motivation

	df	Mean Square	F
Sex	1	.61	.00
Time	1	630.65	64.94*
Group x Time	1	730.69	75.24*
Group x Sex	1	8.44	.87
Group x Sex x Time	1	14.66	1.51

	Control				Treatment			
	Males[a]		Females[b]		Males[c]		Females[d]	
	M	SD	M	SD	M	SD	M	SD
Pretest	30.00	8.25	28.65	8.71	22.87	7.61	23.60	7.52
Posttest	28.75	7.90	29.35	8.85	30.53	8.11	31.00	7.56

Note. Possible scores range from 10 to 50. Higher scores indicate more active enjoyment of mathematics.

[a] $n = 20$.

[b] $n = 46$.

[c] $n = 15$.

[d] $n = 35$.

*$p < .001$.

Appendix I-6

Analysis of Variance by Sex, Group and Time
Teachers

	df	Mean Square	F
Sex	1	698.95	6.76*
Time	1	1.08	.09
Group x Time	1	3.84	.33
Group x Sex	1	.66	.06
Group x Sex x Time	1	.12	.01

	Control				Treatment			
	Males[a]		Females[b]		Males[c]		Females[d]	
	M	SD	M	SD	M	SD	M	SD
Pretest	35.40	7.04	32.72	7.57	29.33	7.51	24.14	8.11
Posttest	35.20	7.10	32.65	7.77	29.60	6.86	24.74	7.71

Note. Possible scores range from 10 to 50. Higher scores indicate perception of more positive teachers' attitudes.

[a] $n = 20$.

[b] $n = 46$.

[c] $n = 15$.

[d] $n = 35$.

*$p < .01$.

Appendix I-7

Analysis of Variance by Sex, Group and Time
A-Trait Anxiety

	df	Mean Square	F
Sex	1	53.98	.39
Time	1	205.36	11.14*
Group x Time	1	292.89	15.88*
Goup x Sex	1	5.21	.28
Group x Sex x Time	1	.25	.01

	Control				Treatment			
	Males[a]		Females[b]		Males[c]		Females[d]	
	M	SD	M	SD	M	SD	M	SD
Pretest	35.25	7.81	38.46	7.33	43.80	13.86	42.06	8.93
Posttest	35.25	7.15	39.26	9.13	39.00	12.11	37.77	7.10

Note. Possible scores range from 20 to 80. Higher scores indicate higher levels of trait anxiety.

[a] $n = 20$.

[b] $n = 46$.

[c] $n = 15$.

[d] $n = 35$.

*$p < .001$.

Appendix I-8

Analysis of Variance by Sex, Group and Time
Test Anxiety

	df	Mean Square	F
Sex	1	398.55	1.33
Time	1	2597.93	62.53*
Group x Time	1	1626.62	39.15*
Group x Sex	1	18.39	.44
Group x Sex x Time	1	3.15	.08

	Control				Treatment			
	Males[a]		Females[b]		Males[c]		Females[d]	
	M	SD	M	SD	M	SD	M	SD
Pretest	37.30	11.00	42.54	13.56	52.20	15.09	51.49	14.31
Posttest	35.40	9.60	41.37	13.91	38.13	12.55	39.17	11.80

Note. Scores may range from 20 to 80. Higher scores indicate higher levels of test anxiety.

[a] $n = 20$.

[b] $n = 46$.

[c] $n = 15$.

[d] $n = 35$.

*$p < .001$.

Appendix I-9

Analysis of Variance by Sex, Group and Time
Worry Component of Test Anxiety

	df	Mean Square	F
Sex	1	129.35	2.77
Time	1	277.81	36.56*
Group x Time	1	166.36	21.89*
Group x Sex	1	2.60	.34
Group x Sex x Time	1	.07	.01

	Control				Treatment			
	Males[a]		Females[b]		Males[c]		Females[d]	
	M	SD	M	SD	M	SD	M	SD
Pretest	13.40	3.76	16.15	5.39	18.60	6.97	19.60	5.92
Posttest	13.05	3.70	15.41	5.30	14.60	5.14	15.06	4.65

Note. Possible scores range from 8 to 32. Higher scores indicate higher levels of worry.

[a] $n = 20$.

[b] $n = 46$.

[c] $n = 15$.

[d] $n = 35$.

*$p < .001$.

Appendix I-10

Analysis of Variance by Sex, Group and Time
Emotionality Component of Test Anxiety

	df	Mean Square	F
Sex	1	16.37	.34
Time	1	457.21	52.96*
Group x Time	1	272.99	31.62*
Group x Sex	1	11.70	1.36
Group x Sex x Time	1	.44	.05

	Control				Treatment			
	Males[a]		Females[b]		Males[c]		Females[d]	
	M	SD	M	SD	M	SD	M	SD
Pretest	16.30	4.86	17.65	5.42	22.00	5.93	20.83	5.86
Posttest	15.20	3.99	17.35	5.77	15.93	4.75	15.94	4.96

Note. Possible scores range from 8 to 32. Higher scores indicate higher levels of emotionality.

[a] $n = 20$.

[b] $n = 46$.

[c] $n = 15$.

[d] $n = 35$.

*$p < .001$.

Appendix I-11

Group x Time F Values

Scale	Pretest	Posttest
Math Anxiety	85.26**	.98
Confidence	52.63**	.20
Male Domain	14.05**	1.00
Usefulness	13.60**	.66
Effectance Motivation	14.01**	1.23
Teacher	28.71**	25.30**
Trait Anxiety	9.20*	.00
Test Anxiety	17.74**	.09
Worry	14.43**	.06
Emotionality	14.49**	.62

*$p < .01$.

**$p < .001$.

REFERENCE NOTES

1. Resnick, L. B. A new conception of mathematics and science learning. Paper presented at the National Convocation on Precollege Education in Mathematics and Science, National Academy of Sciences and National Academy of Engineering, Washington, D. C., May 1982.

2. Probert, B. S. Mathematics and elementary education major: Math anxiety and related variables. Master's Thesis, University of Florida, 1979.

3. Richardson, F. Unpublished survey. The University of Texas at Austin, 1971.

REFERENCES

Aiken, L. R. Attitudes toward mathematics. Review of Educational Research, 1970, 40, 551-596.

Aiken, L. R. Update on attitudes and other affective variables in learning mathematics. Review of Educational Research, 1976, 46, 293-311.

Allen, G. J. Effectiveness of study counseling and desensitization in alleviating test anxiety in college students. Journal of Abnormal Psychology, 1971, 77, 282-289.

Allen, G. J. The behavioral treatment of test anxiety: Recent research and future trends. Behavior Therapy, 1972, 3, 253-262.

Allen, G. J. Treatment of test anxiety by group-administered and self-administered relaxation and study counseling. Behavior Therapy, 1973, 4, 349-360.

Allen, G. J., Elias M. J., & Zlotlow, S. F. Behavioral interventions for alleviating test anxiety: A methodological overview of current therapeutic practices. In I. G. Sarason (Ed.), Test anxiety: Theory, research, and application. Hillsdale, N.J.: Lawrence Erlbaum, 1980.

Alpert, R., & Haber, R. N. Anxiety in academic achievement situations. Journal of Abnormal and Social Psychology, 1960, 61, 207-215.

Anton, W. D., & Klisch, M. C. Perspectives on mathematics anxiety and test anxiety. In C. D. Spielberger & P. Vagg (Eds.), Assessment and treatment of test anxiety. Washington, D.C.: Hemisphere, in press.

Auslander, S. B. Minimizing math anxiety: Help for the sciences. Journal of College Science Teaching, 1979, 19, 17-21.

Bandura, A. Principles of Behavior Modification. New York: Holt, Rinehart & Winston, 1969.

Bandura, A. Self-efficacy: Towards a unifying theory of behavioral change. Psychological Review, 1977, 84, 191-215.

Banks, J. H. Learning and teaching arithmetic. Boston: Allyn & Bacon, 1964.

Bem, S., & Bem, D. J. Case study of a nonconscious ideology: Training the woman to know her place. In D. J. Bem, Beliefs, attitudes, and human affairs. Monterey: Books/Cole, 1970.

Benbow, C. P., & Stanley, J. C. Sex differences in mathematical ability: Fact or artifact? Science, December 12, 1980, pp. 1262-1264.

Betz, N. E. Prevalence, distribution, and correlates of math anxiety in college students. Journal of Counseling Psychology, 1978, 25, 441-448.

Blacks do better on college boards. Gainesville Sun, October 14, 1982, p. 7A.

Blum, L. Count me in: Educating women for science and math. Newton, Mass.: Education Development Center, 1978.

Casserly, P. L. An assessment of factors affecting female participation in advanced placement programs in mathematics, chemistry, and physics. In L. H. Fox, L. Brody, & D. Tobin (Eds.), Women and the mathematical mystique. Baltimore, Md.: Johns Hopkins University Press, 1980.

Cautela, J. R. Behavior therapy and self control: Techniques and implications. In C. M. Franks (Ed.), Behavior therapy: Appraisal and status. New York: McGraw-Hill, 1969.

Comber, L. C., & Keevers, J. Science achievement in nineteen countries. New York: Wiley, 1973.

Cordes, C. Interest is high, funds low to bolster science education. APA Monitor, July, 1982, pp. 3; 16.

Cunningham, R. Graham claims math, science education lag. Gainesville Sun, September 19, 1981, p. 5B.

Deffenbacher, J. L. Relationship of worry and emotionality to performance on the Miller Analogies Test. Journal of Educational Psychology, 1977, 89, 191-195.

Deffenbacher, J. L. Worry and emotionality in test anxiety. In I. G. Sarason (Ed.), Test anxiety: Theory, research, and applicatiçn. Hillsdale, N.J.: Lawrence Erlbaum, 1980.

Denney, D. R. Self-control approaches to the treatment of test anxiety. In I. G. Sarason (Ed.), Test anxiety: Theory, research, and application. Hillsdale, N.J.: Lawrence Erlbaum, 1980.

Dreger, R. M., & Aiken, L. R. The identification of number anxiety in a college population. Journal of Educational Psychology, 1957, 48, 344-451.

Ellis, A. Reason and emotion in psychotherapy. New York: Stuart, 1962.

Ernest, J. Mathematics and sex. The American Mathematical Monthly, 1976, 83, 595-614.

Ernest, J. Sex, sexism and anxiety in mathematics. In J. Jacobs (Ed.), Perspectives on women and mathematics. Columbus: ERIC, 1978. (ERIC Document Reproduction Service No. ED 166051)

Fennema, E. Mathematics learning and the sexes: A review. Journal for Research in Mathematics Education, 1974, 5, 126-139.

Fennema, E. Influences of selected cognitive, affective, and educational variables on sex-related differences in mathematics learning and studying. In Women and mathematics: Research perspectives for change (NIE Papers in Education and Work: No. 8). Washington, D.C.: U.S. Department of HEW, 1977.

Fennema, E., & Sherman, J. Fennema-Sherman mathematics attitudes scales: Instruments designed to measure attitudes toward the learning of mathematics by males and females. JSAS. Catalog of Selected Documents in Psychology, 1976, 6, 31.

Fennema, E., & Sherman, J. Sex-related differences in mathematics achievement, spatial visualization, and affective factors. American Educational Research Journal, 1977, 14, 51-71.

Fox, L. The effects of sex role socialization on mathematics participation and achievement. In Women and mathematics: Research perspectives for change (NIE Papers in Education and Work: No. 8). Washington D.C.: U.S. Department of HEW, 1977.

Glaser, N. Social and cultural factors in economic growth. In H. Patrick & H. Rosovsky (Eds.), Asia's new giant. Washington, D.C.: Brookings Institution, 1976.

Goldfried, M. R. Systematic desensitization as training in self-control. Journal of Consulting and Clinical Psychology, 1971, 37, 228-234.

Goldfried, M. R. The use of relaxation and cognitive relabeling as coping skills. In R. B. Stuart (Ed.), Behavioral self management: Strategies, techniques, and outcomes. New York: Brunner/Mazel, 1977.

Gough, M. F. Mathemaphobia: Causes and treatments. The Clearing House, 1954, 28, 290-294.

Gray, M. The mathematical education of women. The American Mathematical Monthly, 1977, 84, 374-377.

Hahnloser, R. M. A comparison of cognitive restructuring and progressive relaxation in test anxiety reduction. (Doctoral dissertation, University of Oregon, 1974). Dissertation Abstracts International, 1974, 35, 1444A-1445A. (University Microfilms No. 74-18, 897)

Haines, A. P., Jr. State officials say new programs will counter decline in education. Independent Florida Alligator, September 9, 1982, p. 22.

Helson, R. The creative woman mathematician. In L. H. Fox, L. Brody, & D. Tobin (Eds.), Women and the mathematical mystique. Baltimore: Johns Hopkins University Press, 1980.

Hendel, D. D., & Davis, S. O. Effectiveness of an intervention strategy for reducing mathematics anxiety. Journal of Counseling Psychology, 1978, 25, 429-434.

Hilton, P. Math anxiety: Some suggested causes and cures. Two-Year College Mathematics Journal, 1980, 11, 174-188.

Holroyd, K. A. Cognition and desensitization in the group treatment of test anxiety. Journal of Consulting and Clinical Psychology, 1976, 44, 991-1001.

Hyde, J. How large are cognitive gender differences? A meta-analysis using w^2 and d. American Psychologist, 1981, 36, 892-901.

Keisling, P. How to save the public schools. New Republic, November 1, 1982, pp. 27-32.

Kogelman, S., & Warren, J. Mind over math. New York: Dial Press, 1978.

Lakein, A. How to get control of your time and your life. New York: David McKay Co., 1973.

Lazarus, A. A. (Ed.), Multimodal behavior therapy. New York: Springer, 1976.

Lazarus, M. Mathophobia: Some personal speculations. National Elementary Principal, 1974, 53(2), 16-22.

Liebert, R. M., & Morris, L. W. Cognitive and emotional components of test anxiety: A distinction and some initial data. Psychological Reports, 1967, 20, 975-978.

Luchins, E. H. Sex differences in mathematics: How not to deal with them. American Mathematical Monthly, 1979, 86, 161-168.

Maccoby, E., & Jacklin, C. Psychology of sex differences. Palo Alto, Calif.: Stanford University Press, 1974.

Mallow, J. V. Science anxiety: Fear of science and how to overcome it. New York: Van Nostrand Reinhold, 1981.

Mander, G., & Sarason, S. B. A study of anxiety and learning. Journal of Abnormal and Social Psychology, 1952, 47, 166-173.

Meichenbaum, D. Cognitive modification of test-anxious college students. Journal of Consulting and Clinical Psychology, 1972, 39, 370-380.

Meichenbaum, D. A self-instructional approach to stress management: A proposal for stress inoculation training. In C. Spielberger and I. Sarason (Eds.). Stress and anxiety in modern life. Washington, D.C.: Hemisphere, 1975.

Meichenbaum, D. Cognitive-behavior modification. New York: Plenum, 1977.

Meichenbaum, D., & Butler, L. Toward a conceptual model for the treatment of test anxiety: Implications for research and treatment. In I. G. Sarason (Ed.), Test anxiety: Theory, research, and application. Hillsdale, N.J.: Lawrence Erlbaum, 1980.

Murray, E. J., & Jacobson, L. I. Cognition and learning in traditional and behavioral therapy. In S. L. Garfield & A. E. Bergin (Eds.), Handbook of psychotherapy and behavior change. New York: Wiley, 1978.

Natkin, G. L. The treatment of mathematical anxiety through mediated transfer of attitude toward mathematics. (Doctoral dissertation, Indiana University, 1966). Dissertation Abstracts International, 1967, 27A, 4137. (University Microfilms No. 67-03698)

Panel told high school math lacking. Gainesville Sun, April 16, 1982, p. 6A.

Paul, C. The mathematics teacher shortage--some solutions. Mathematics Teacher, 1981, 74, 173-177.

Poffenberger, T., & Norton, D. A. Factors determining attitudes toward arithmetic and mathematics. The Arithmetic Teacher, 1956, 3, 113-116.

Polya, G. How to solve it. Princeton: Priceton University Press, 1957.

Posamentier, A. S., & Stepelman, J. A shortage of mathematics teachers in New York City. Mathematics Teacher, 1982, 75, 588-590.

Richardson, F. C. Anxiety management training: A multimodal approach. In A. Lazarus (Ed.), Multimodal behavior therapy. New York: Springer, 1976.

Richardson, F. C., & Suinn, R. M. The Mathematics Anxiety Rating Scale: Psychometric data. Journal of Counseling Psychology, 1972, 19, 551-554.

Richardson, F. C., & Suinn, R. M. A comparison of traditional systematic desensitization, accelerated massed desensitization, and anxiety management training in the treatment of mathematics anxiety. Behavior Therapy, 1973, 4, 212-218.

Richardson, F. C., & Woolfolk, R. L. Mathematics anxiety: In I. G. Sarason (Ed.), Test anxiety: Theory, research, and application. Hillsdale, N.J.: Lawrence Erlbaum, 1980.

Sarason, I. G. Interrelationships among individual difference variables, behavior in psychotherapy, and verbal conditioning. Journal of Abnormal and Social Psychology, 1958, 56, 339-344.

Sawyer, W. W. Mathematician's delight. Baltimore: Penguin, 1943.

Sawyer, W. W. Vision in elementary mathematics. Baltimore: Penguin, 1964.

Schafer, A. T., & Gray, M. W. Sex and mathematics. Science, January 16, 1981, p. 231.

Sells, L. High school mathematics as the critical filter in the job market. In Developing opportunities for minorities in graduate education. University of California, Berkeley: Proceedings of the Conference on Minority Graduate Education, 1973.

Sells, L. Mathematics--A critical filter. The Science Teacher, 1978a, 45(2), 28-29.

Sells, L. Political implications of data for generating change. In The problem of math anxiety. The School of Natural Sciences, California State University, Fresno: Proceedings of the Conference on Math Anxiety, 1978b.

Sells, L. The mathematics filter and the education of women and minorities. In L. H. Fox, L. Brody, & D. Tobin (Eds.), Women and the mathematical mystique. Baltimore: Johns Hopkins University Press, 1980.

Sherman, J. Effects of biological factors on sex-related differences in mathematics achievement. In Women and mathematics: Research perspectives for change (NIE Papers in Education and Work: No. 8). Washington, D.C.: U.S. Department of HEW, 1977.

Sherman, J. Sex-related cognitive differences: An essay on theory and evidence. Springfield, Ill.: Charles C. Thomas, 1979.

Sherman, J. Girls' and boys' enrollment in theoretical math courses: A longitudinal study. Psychology of Women Quarterly, 1981, 5, 681-689.

Sherman, J., & Fennema, E. The study of mathematics by high school girls and boys: Related variables. American Educational Research Journal, 1977, 14, 159-168.

Skemp, R. R. The psychology of learning mathematics. Baltimore: Penguin Books, 1971.

Snow, C. P. The two cultures and the scientific revolution. Cambridge, England: Cambridge University Press, 1959.

Solano, C. H. Teachers and pupil stereotypes of gifted boys and girls. Talents and Gifts, 1977, 19, 4.

Spielberger, C. D., Gonzalez, H. P., Taylor, C., Algaze, B., & Anton, W. D. Examination stress and test anxiety. In C. D. Spielberger & I. G. Sarason (Eds.), Stress and Anxiety (Vol. 5). New York: Hemisphere/Wiley, 1978.

Spielberger, C. D., Gonzalez, H. P., Taylor, C. J., Anton, W. D., Algaze, B., Ross, G. R., & Westberry, L. G. Preliminary Professional Manual for the Test Anxiety Inventory. Palo Alto, Calif.: Consulting Psychologists Press, 1980.

Spielberger, C. D., Gorsuch, R. L., & Lushene, R. E. Manual for the State-Trait Anxiety Inventory. Palo Alto, Calif.: Consulting Psychologists Press, 1970.

Stigler, J. W., Lee, S., Lucker, G. W., & Stevenson, H. W. Curriculum and achievement in mathematics: A study of elementary school children in Japan, Taiwan, and the United States. Journal of Educational Psychology, 1982, 74, 315-322.

Suinn, R. The application of short-term videotape therapy for the treatment of test anxiety of college students. Progress report. Fort Collins, Colo.: Colordao State University, 1970.

Suinn, R. Mathematics Anxiety Ratings Scale (MARS). Fort Collins, Colo.: RMBSI, 1972.

Suinn, R., Edie, C., & Spinelli, P., Accelerated massed desensitization: Innovation in short-term treatment. Behavior Therapy, 1970, 1, 303-311.

Suinn, R. M., & Richardson, F. Anxiety management training: A nonspecific behavior therapy program for anxiety control. Behavior Therapy, 1971, 2, 498-510.

Tobias, S. Math anxiety: What is it and what can be done about it? Ms, September, 1976, pp. 56-59.

Tobias, S. Overcoming math anxiety. New York: W. W. Norton, 1978.

Tob as, S. Forward. In J. Mallow, Science anxiety: Fear of science and how to overcome it. New York: Van Nostrand Reinhold, 1981.

Tob as, S. Sexist equations. Psychology Today, January, 1982, pp. 14-16; 17.

Tob as, S., & Knight, L. Math anxiety and the adult learner. Lifelong Learning: The Adult Years, 1978, 2, 4-8.

Tob as, S., & Weissbrod, C. Anxiety and mathematics: An update. Harvard Educational Review, 1980, 50, 63-70.

Try n, G. S. The measurement and treatment of test anxiety. Review of Educational Research, 1980, 50, 343-372.

Tur ington, C. Computers in class: Who gets to learn? APA Monitor, June 1982, pp. 1; 30.

Win , J. D. Test anxiety and direction of attention. Psychological Bulletin, 1971, 76, 92-104.

Win , J. D. Cognitive-attentional theory of test anxiety. In I. G. Sarason (Ed.), Test anxiety: Theory, research, and application. Hillsdale, N.J.: Lawrence Erlbaum, 1980.

Wol e, J. Psychotherapy by reciprocal inhibition. Stanford, Calif.: Stanford University Press, 1958.

Woo folk, R. L., & Richardson, F. C. Stress, sanity, and survival. New York: Signet, 1978.

Zac arias, J. R. Apples, oranges, and abstractions: A matter of math. National Elementary Principal, 1976 56, 20-27.

Zil er, R. C. The Social Self. New York: Pergamon Press Inc., 1973.

BIOGRAPHICAL SKETCH

Barbara S. Probert was born July 28, 1929, in Portland, Oregon. From 1947 to 1951 she attended the University of Oregon from which she received the Phi Beta Kappa Sophomore Book Award and the Gerlinger Cup for Outstanding Junior Woman. She was also selected to be a member of Phi Beta Kappa ("Senior Six") and Mortar Board and was elected as president of the Associated Women Students. She received a Bachelor of Arts degree in 1951. She and her husband, Walter, to whom she was married in 1952, have two sons, Richard Walter and James Stevenson.

After various professional experiences, she enrolled in the Graduate School of the University of Florida in counseling psychology and was later elected to Phi Kappa Phi. She received a Master of Arts degree in December, 1979. In the summer of 1980 she and Dr. Paul G. Schauble established a Math Anxiety Clinic with the cosponsorship of the University of Florida Counseling Center and the Department of Mathematics. Since completing a year's doctoral counseling psychology internship at the Counseling Center in 1981, she has been employed there as a Counseling Psychology Associate and Coordinator of the Math Anxiety Clinic. In 1982 she received the Ann Q. Lynch

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I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

Paul G. Schauble, Chairman
Professor of Psychology

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Rosie P. Bingham
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Greg J. Neimeyer
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This dissertation was submitted to the Graduate Faculty of the Department of Psychology in the College of Liberal Arts and Sciences and to the Graduate Council, and was accepted as partial fulfillment of the requirements for the degree of Doctor of Philosophy.

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